



# HOMESTAKE MINING COMPANY NPL SITE BACKGROUND STUDY

EPA/NM/BVDA/MASE MEETING  
SEPTEMBER 12, 2019  
Albuquerque, NM

# Regulatory Responsibilities



## U.S. Nuclear Regulatory Commission [NRC]

- Regulates reclamation and closure of inactive uranium mill sites
  - 1978 Uranium Mill Tailing Radiation Control Act [UMTRCA]
  - National closure standards
  - Ground water standards (or background or Alternate Concentration Limits)



## U.S. EPA

- Regulates remediation under 1980 Superfund Law
- Selects site-specific remedies
  - Technical evaluation of contamination, risk, and cleanup options
  - Ground water standards (or background or ACLs)



## N.M. Environment Department

- Regulates protection of ground water under NM Water Quality Act
  - Ground water discharge permitting program
  - Ground water standards (or background or ACLs)

# ORIGINAL BACKGROUND CHARACTERIZATION



- 2004 HOMESTAKE PERFORMS STATISTICAL BACKGROUND STUDY
  - Homestake Requests NRC Cleanup Standards be revised to reflect background
- 2006 NRC and NMED Approve Revised Cleanup Standards
  - EPA Agrees with New Cleanup Levels

# EPA PERFORMS BACKGROUND REASSESSMENT AT REQUEST OF BVDA

- 2016 – EPA/USGS GROUND WATER SAMPLING AND GEOPHYSICS
  - Homestake/ARCADIS collect Split Samples
- 2018 – HOMESTAKE/ARCADIS BACKGROUND STUDY
  - Alluvial Ground Water Sampling
  - Lithology/Mineralogy Characterization near DD/DD2
  - Submits White Paper – October 26, 2018
- 2019 – HOMESTAKE/ARCADIS SUPPLEMENTAL BACKGROUND STUDY
  - Augment Understanding of Hydrogeology, Geochemistry, Alluvial Channel Geometry

# CHRONOLOGY FOR 2019 HOMESTAKE/ARCADIS SUPPLEMENTAL BACKGROUND STUDY

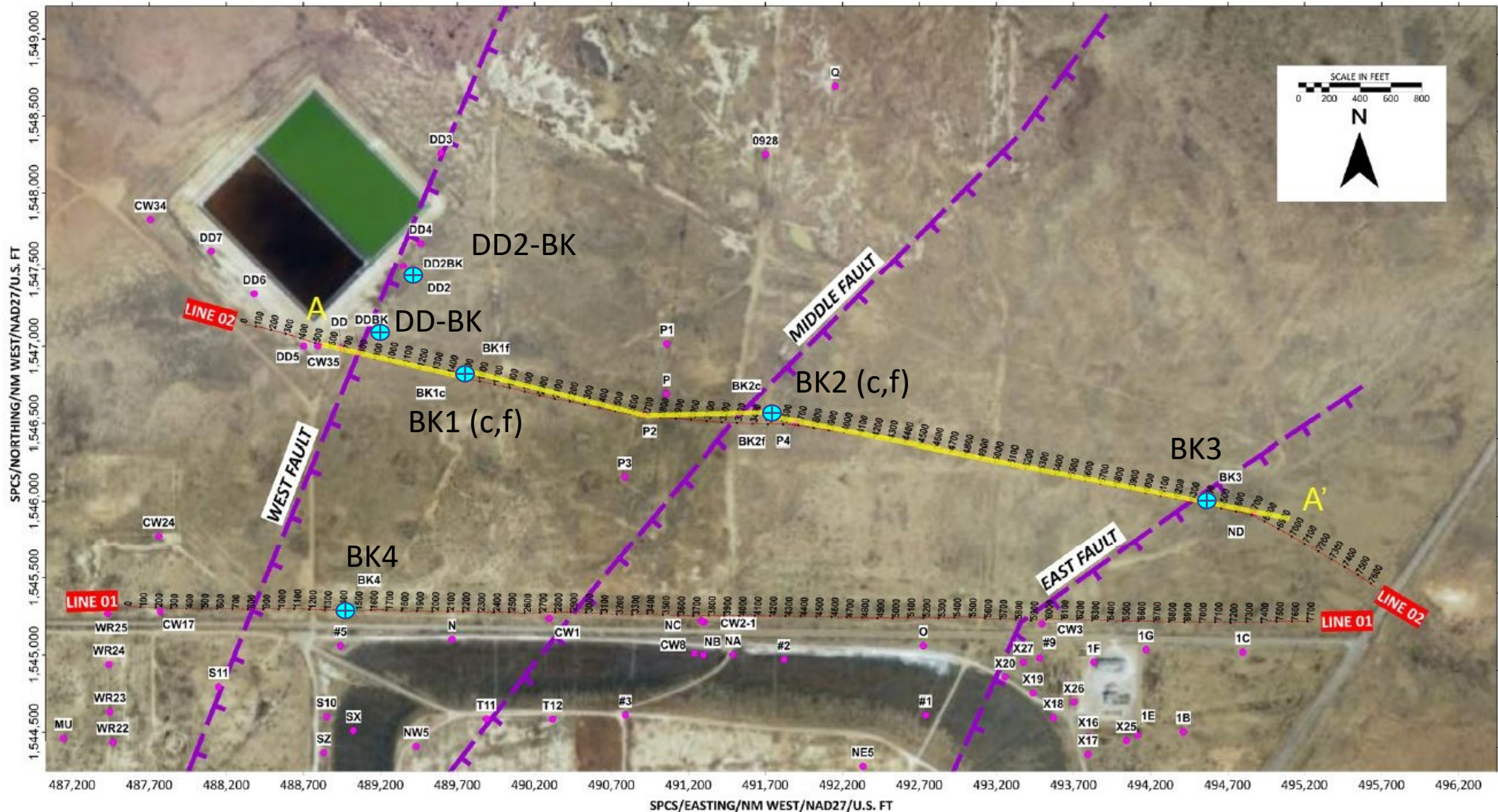
- FEBRUARY 13, 2019 – *Homestake Submits Work Plan*
- MARCH 13, 2019 – *EPA/NM/Homestake Meeting on Modifications*
- MAY 2, 2019 – *EPA/NM/Homestake Collaborate on Drilling Locations*
- MAY 14, 2019 – *Homestake Submits Revised Work Plan*
- JUNE 18, 2019 – *EPA/NM Meet with BVDA, MASE, Congress. Staffers*
- AUGUST 14, 2019 – *EPA/NM/Homestake Meeting on Results*
- AUGUST 21, 2019 – *EPA Panel of Experts Discuss ARCADIS Results*
- SEPTEMBER 10, 2019 – *Homestake presents 2019 Results to EPA Panel*
- SEPTEMBER 12, 2019 – *EPA/NM Meet with BVDA and MASE*

# SUMMARY OF 2019 SUPPLEMENTAL BACKGROUND STUDY RESULTS

- DRILLING, LITHOLOGY, AND GEOCHEMICAL ASSESSMENT
  - Geologic Logging and Core Assessment
  - X-Ray Diffraction, Petrography, Scanning Electron Microscopy
  - Selective Sequential Extraction
  - Ground Water Sampling and Analysis
- GEOPHYSICAL ASSESSMENT
  - Electrical Resistivity Tomography
  - Borehole Geophysics



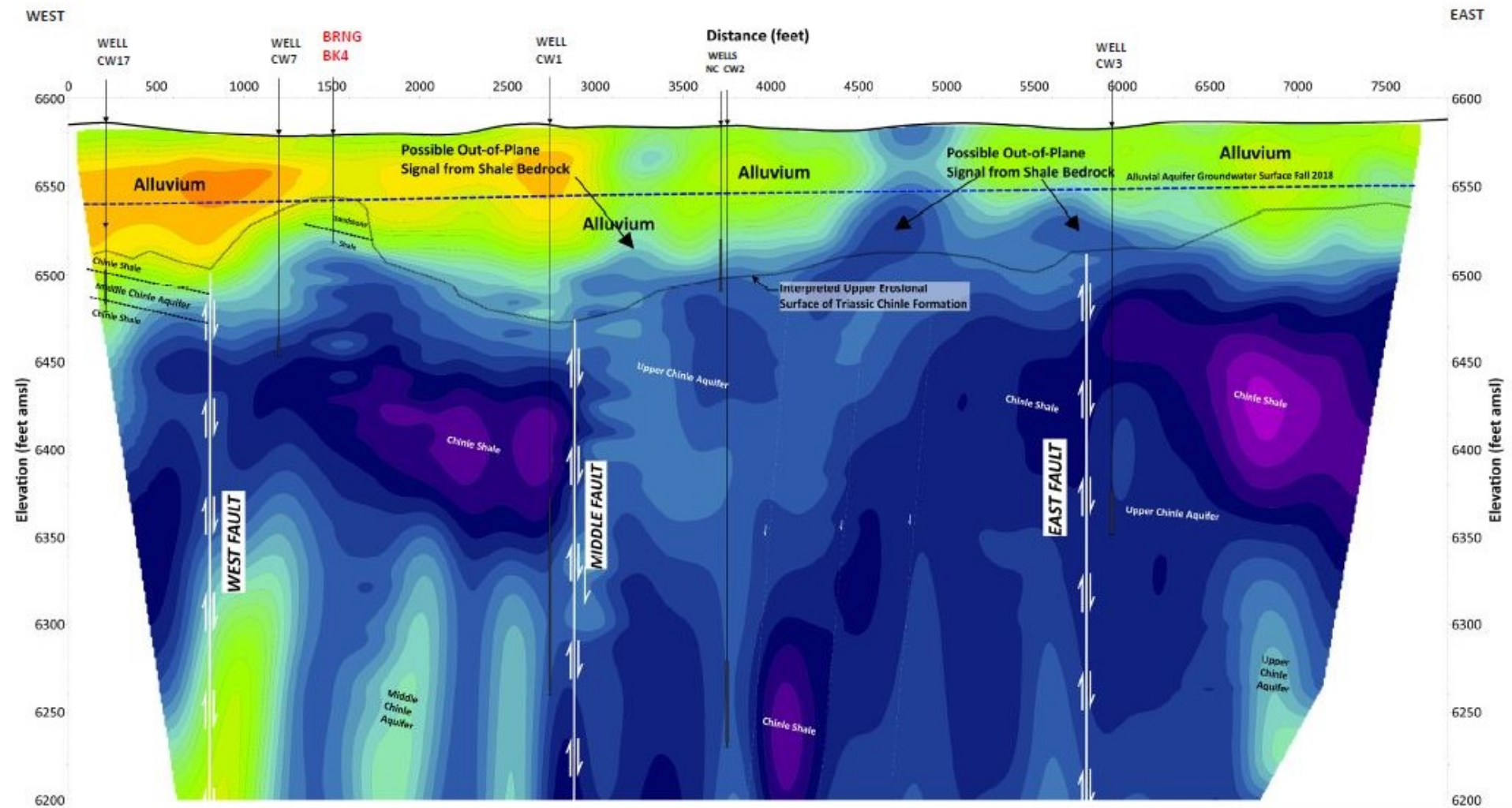
# SUPPLEMENTAL BACKGROUND STUDY AREA





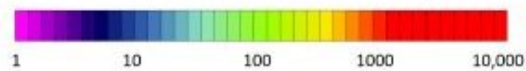






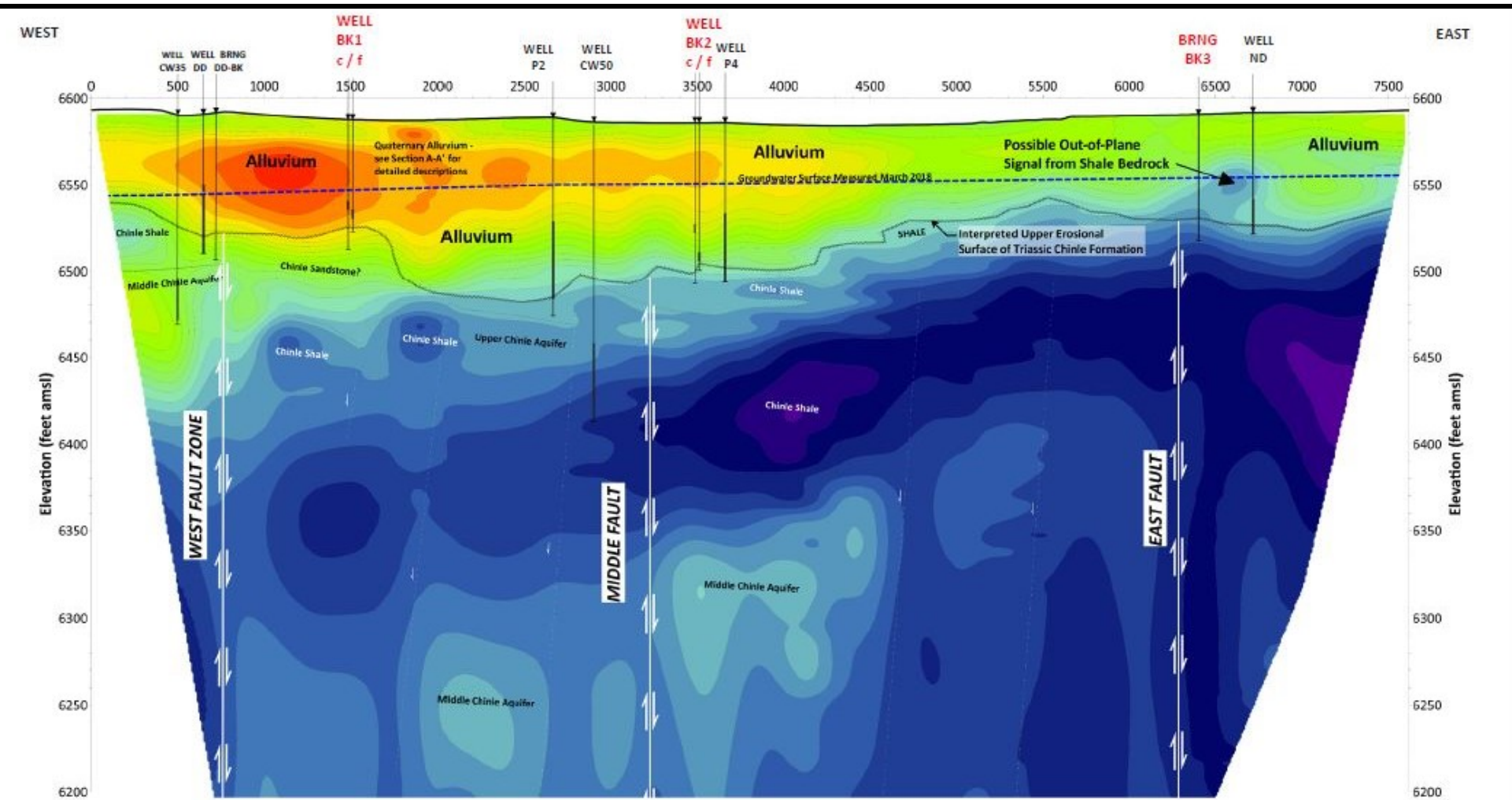
VERTICAL EXAGGERATION = 10X

ELECTRICAL RESISTIVITY (OHM-METERS)

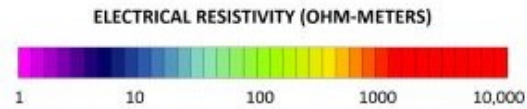


HOMESTAKE MINING COMPANY  
GRANTS RECLAMATION PROJECT  
SUPPLEMENTAL BACKGROUND SOIL AND GROUNDWATER  
INVESTIGATION REPORT

ERT LINE 1  
2D INVERSION MODEL



VERTICAL EXAGGERATION = 10X

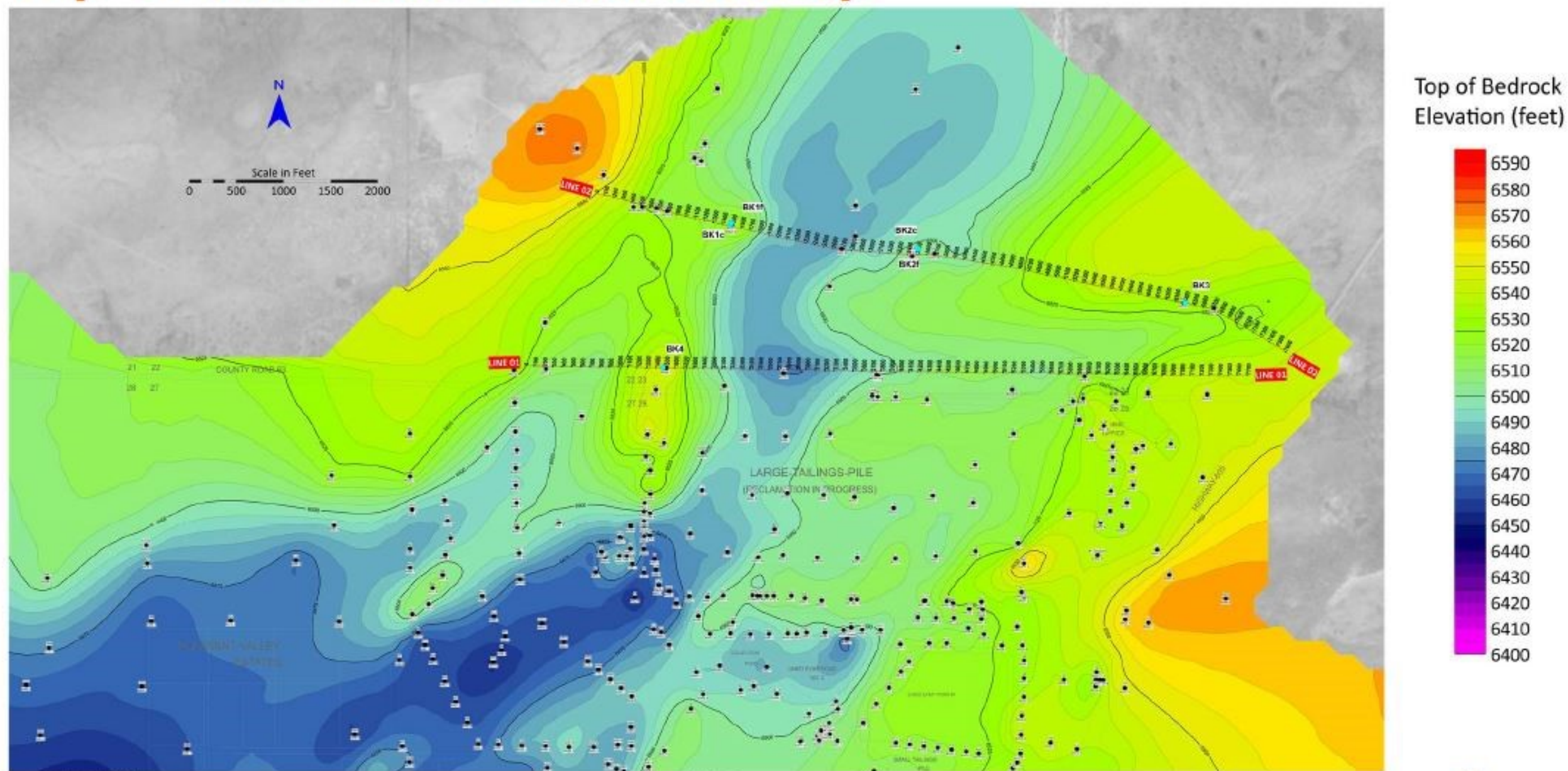


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INVESTIGATION REPORT

ERT LINE 2  
2D INVERSION MODEL



# Top of bedrock elevation map



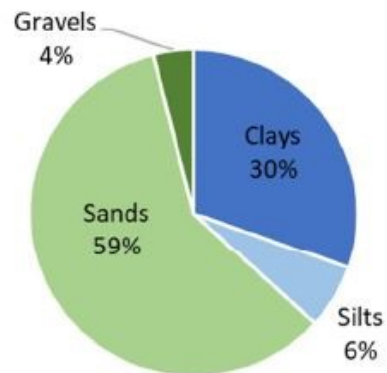
# LITHOLOGY/ MINERALOGY



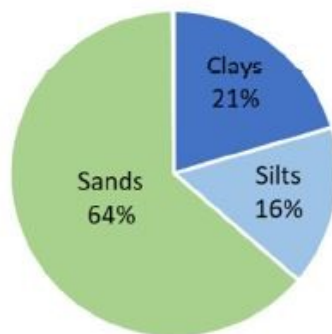


West

DD2-BK



DD-BK



Clays

Silts

Sands

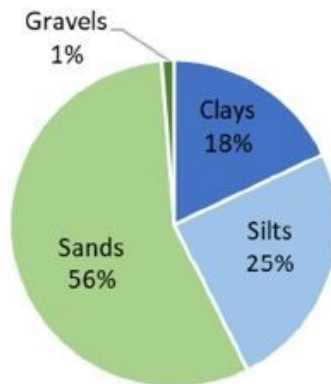
Gravels

Fine

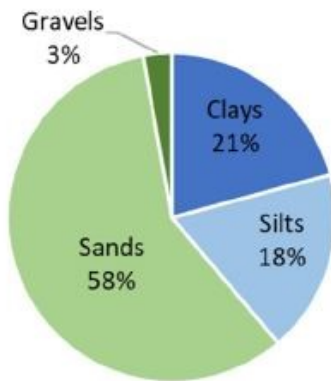
Coarse

North

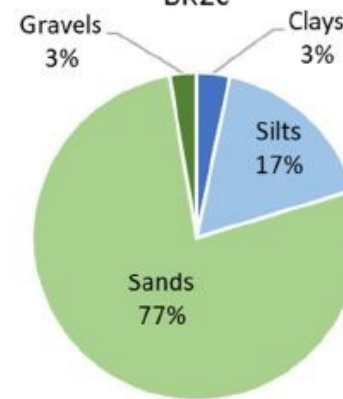
BK1c



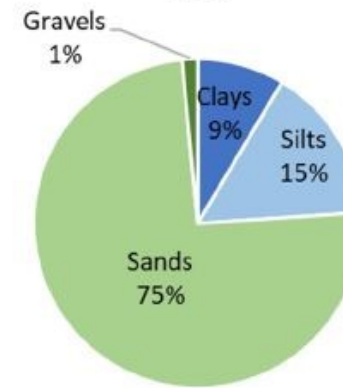
BK1f



BK2c

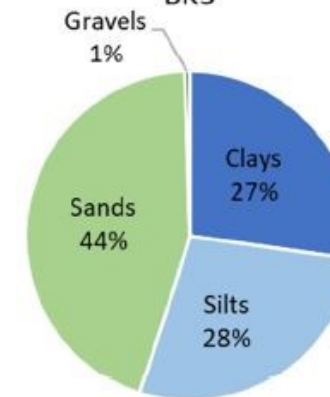


BK2f

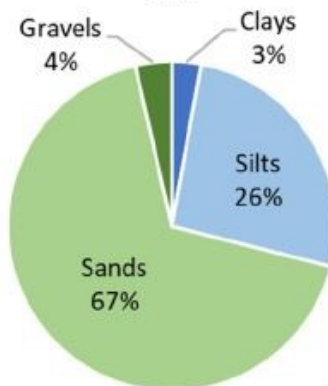


East

BK3



BK4



South

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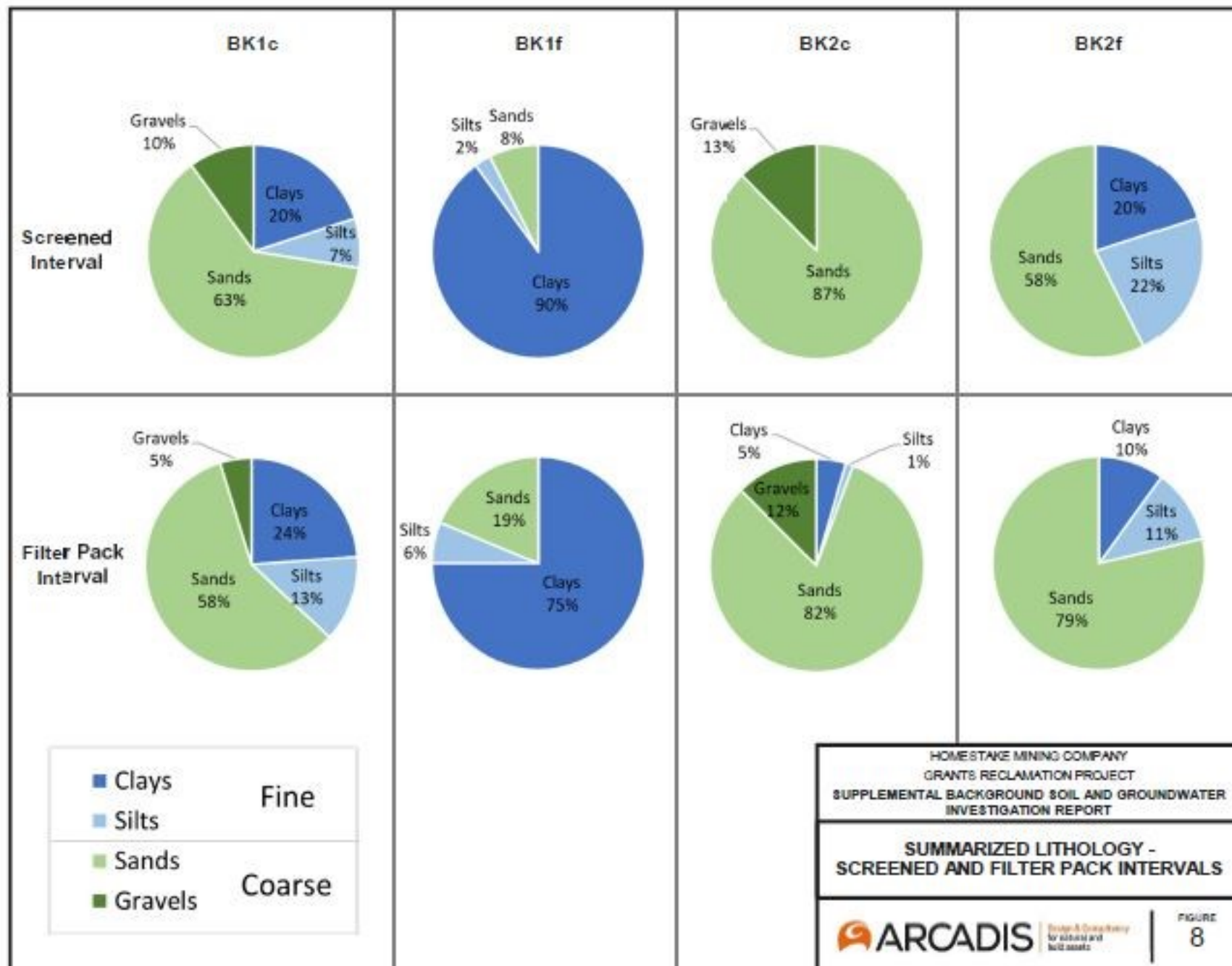
SUMMARIZED LITHOLOGY  
PER BOREHOLE

ARCADIS

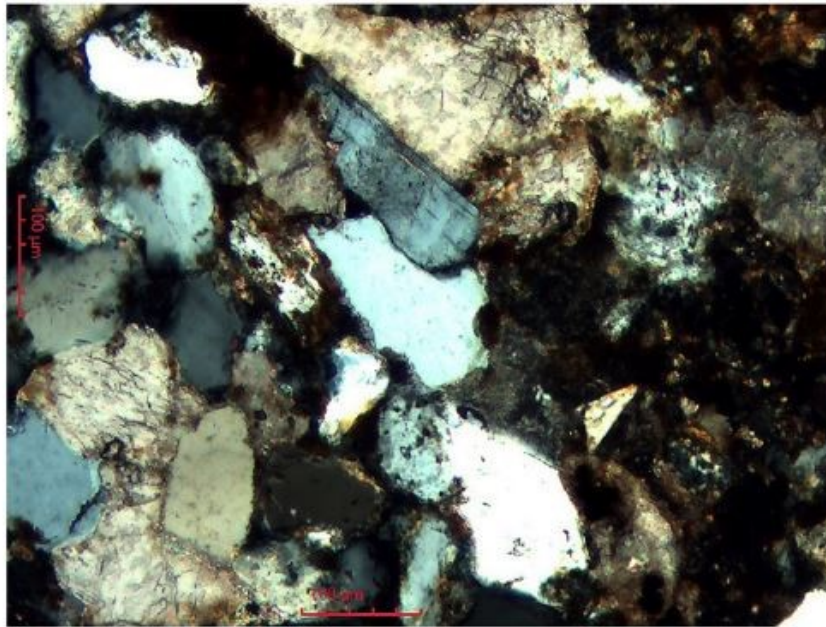
Design & Consultancy  
for natural and  
built assets

FIGURE

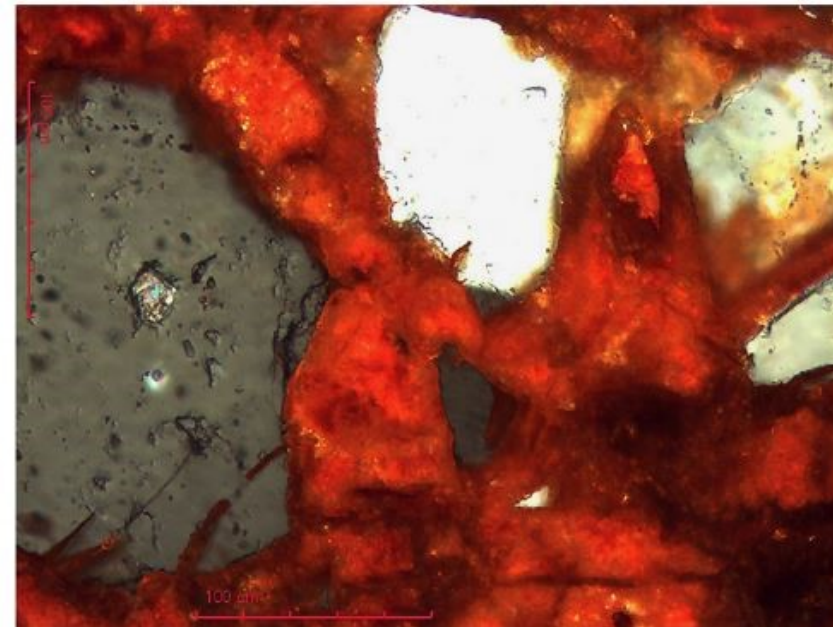
7







Client Sample No.: **BK1-51-52-052119**  
 Fragment of calcite cemented arkose – 100X PL



Client Sample No.: **BK1-52-53-052119**  
 Iron oxide cementing quartz fragments – 200X RL



Client Sample No.: **BK1-39-40-052119**  
 Black carbon with quartz/feldspar – 200X PL

#### Notes

µm – micrometer  
 PL – polarized light  
 RL – reflected light

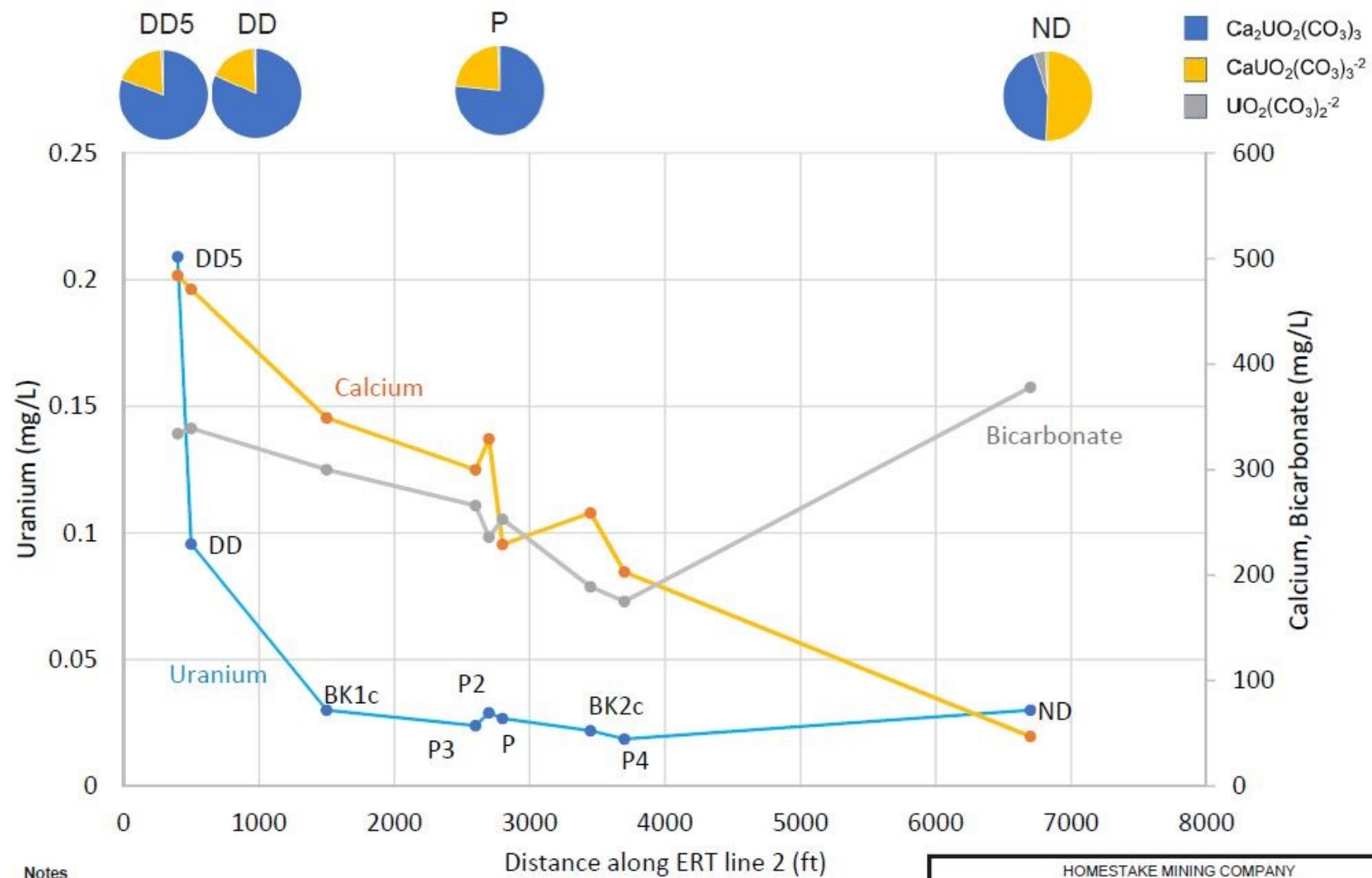
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 GRANTS RECLAMATION PROJECT  
 SUPPLEMENTAL BACKGROUND SOIL AND GROUNDWATER  
 INVESTIGATION REPORT

#### COMMON MINERAL CONSORTIA

# GEOCHEMISTRY





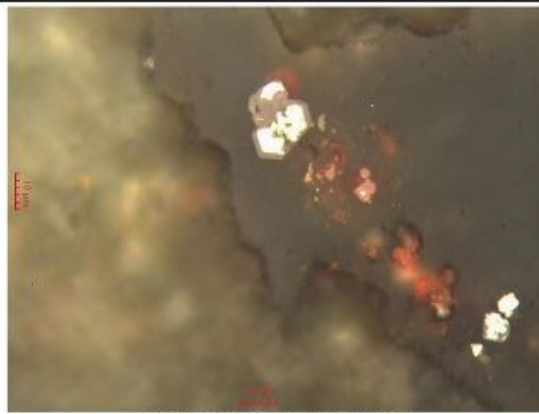


Notes  
ft – feet  
mg/L – milligram per liter

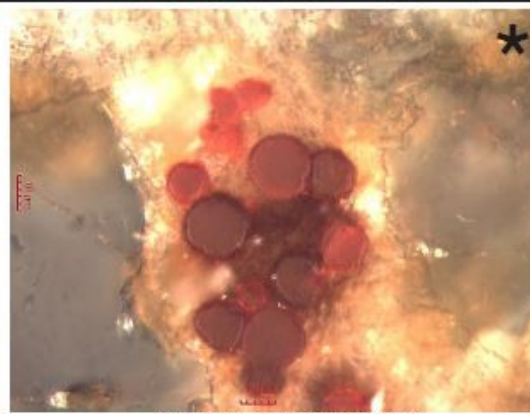
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INVESTIGATION REPORT

GROUNDWATER CALCIUM,  
BICARBONATE, AND URANIUM

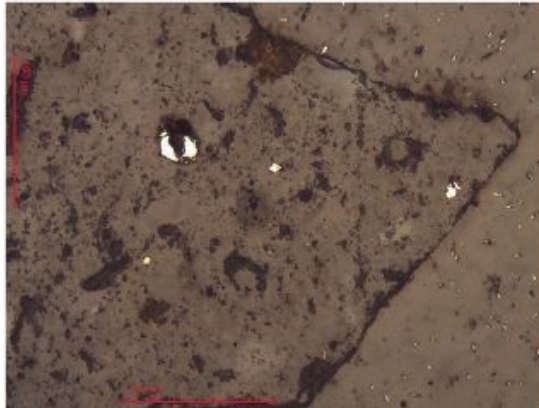
# PYRITE FORMS ACROSS ALLUVIAL PALEO CHANNEL



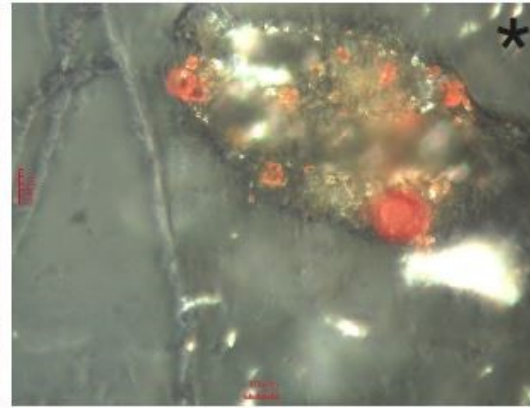
Client Sample No.: BK1-52-53-052119  
Pyrite in quartz showing partial to complete replacement by goethite – 500X RL



Client Sample No.: BK1-51-52-052119  
Goethite pseudomorphs after pyrite framboids. 500X



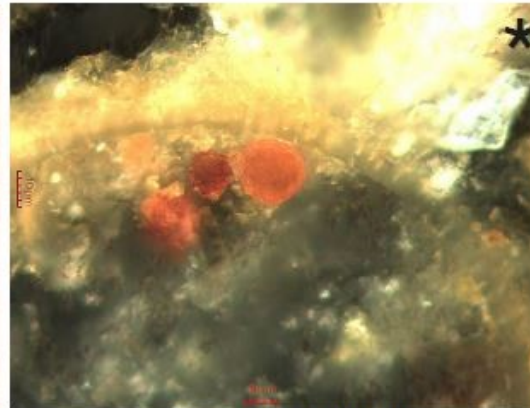
Client Sample No.: BK2-63-5-64-5-051619  
Angular grain of chert with inclusions of bright pyrite – 200X RL



Client Sample No.: BK2-35-36-052119  
Goethite pseudomorphs after pyrite framboids. 500X



Client Sample No.: BK3-42-5-43-5-052219  
Small cube of bright pyrite in carbon – 200X RL



Client Sample No.: BK3-47-5-48-5-052119  
Goethite pseudomorphs after pyrite framboids. 500X

## Notes

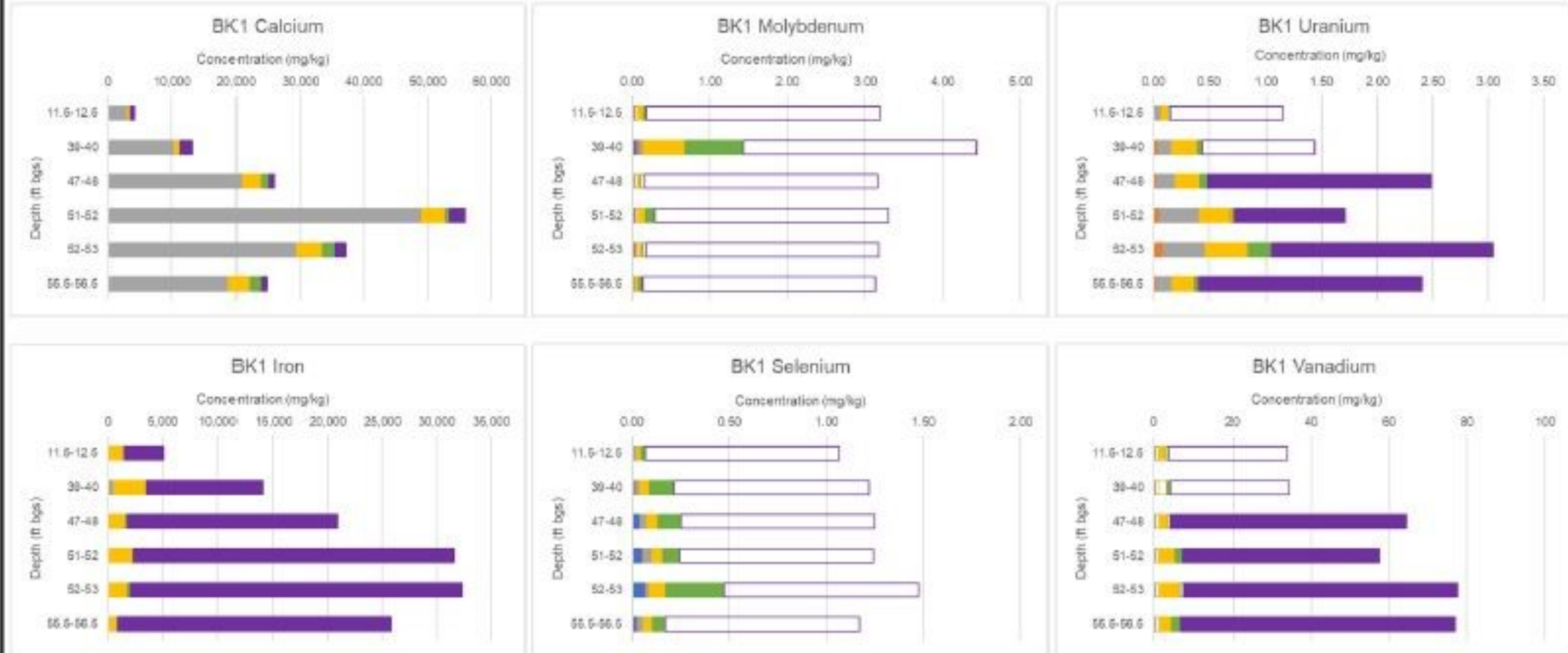
★ - Image provided from work completed after formal laboratory report was issued.

µm – micrometer

RL – reflected light

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GRANTS RECLAMATION PROJECT  
SUPPLEMENTAL BACKGROUND SOIL AND GROUNDWATER  
INVESTIGATION REPORT

PYRITE FORMS ACROSS THE CHANNEL



#### Notes

Bar with white fill and colored outline indicates a non-detect result with the value reported as the method detection limit (MDL) in mg/kg.

bgs – below ground surface

ft – feet

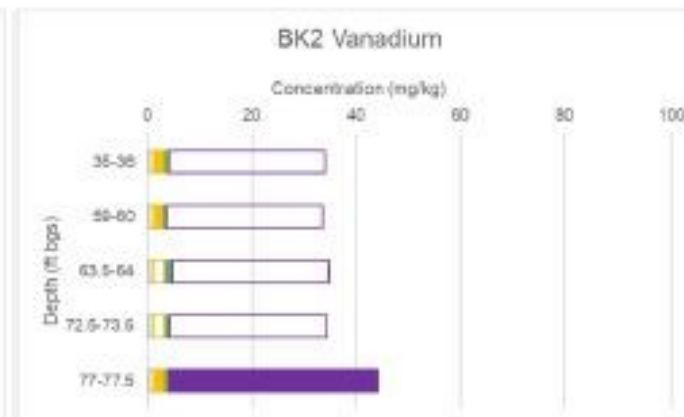
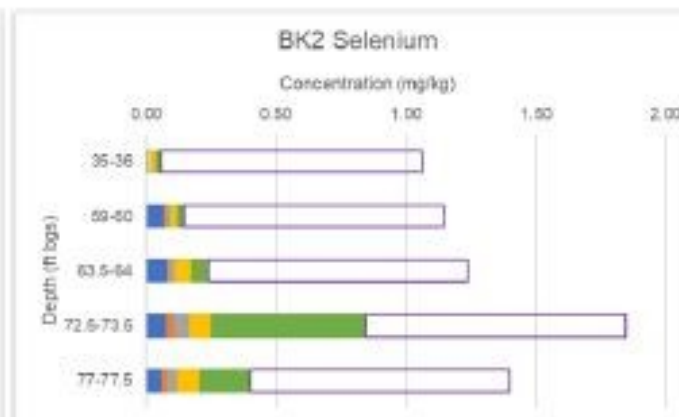
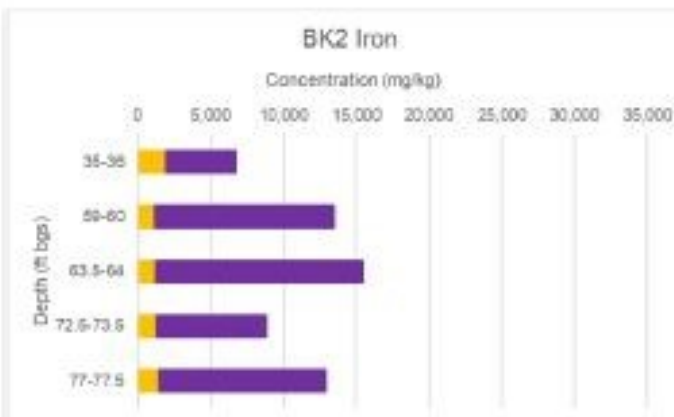
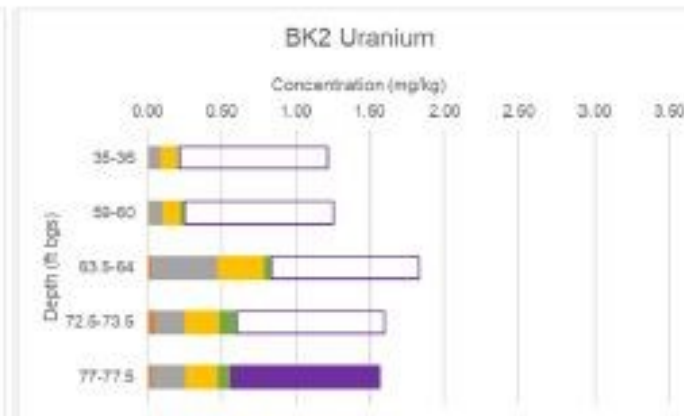
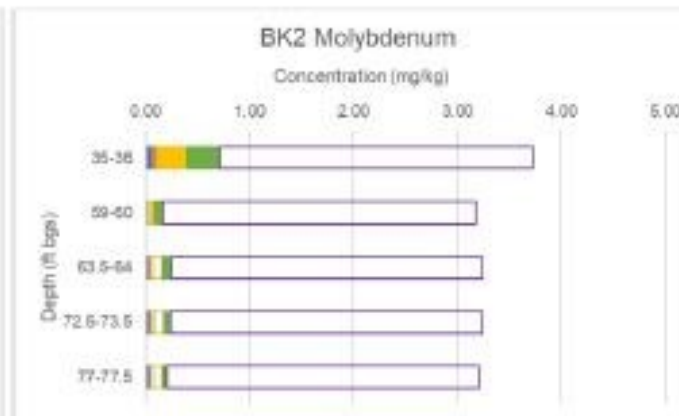
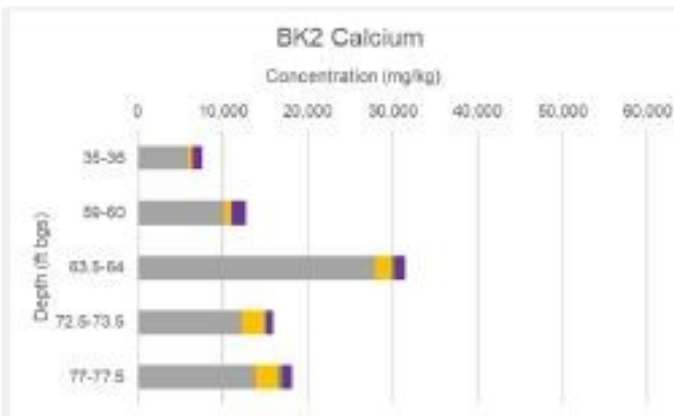
mg/kg – milligrams per kilogram

- Water Soluble
- Adsorbed
- Carbonate Bound
- Oxide Bound
- Organic/Sulfide Bound
- Residual

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### SELECTIVE SEQUENTIAL EXTRACTION RESULTS – BK1





#### Notes

Bar with white fill and colored outline indicates a non-detect result with the value reported as the method detection limit (MDL) in mg/kg.

bgs – below ground surface

ft – feet

mg/kg – milligrams per kilogram

■ Water Soluble

■ Adsorbed

■ Carbonate Bound

■ Oxide Bound

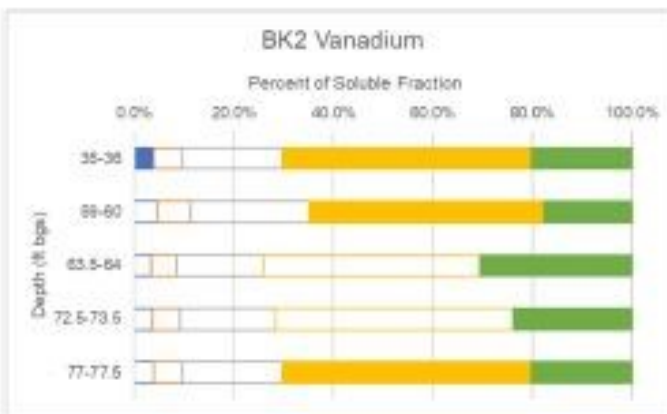
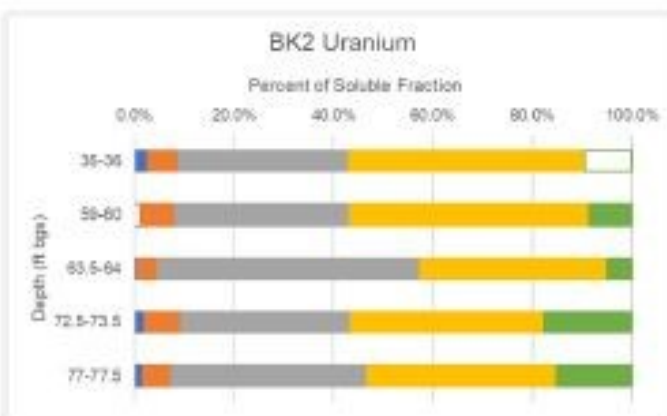
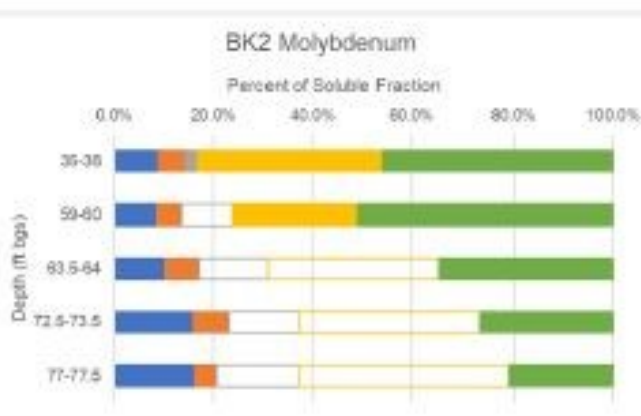
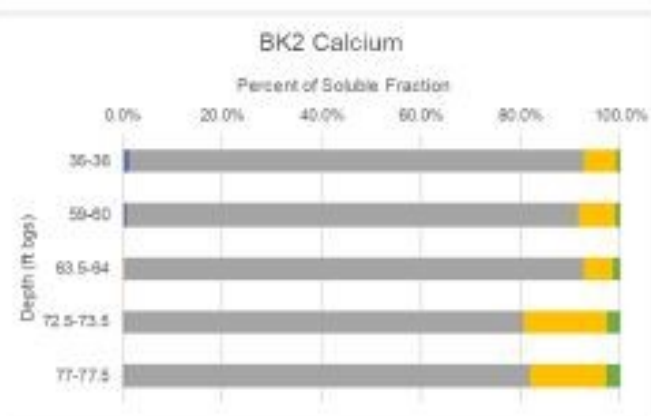
■ Organic/Sulfide Bound

■ Residual

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SUPPLEMENTAL BACKGROUND SOIL AND GROUNDWATER  
INVESTIGATION REPORT

**SELECTIVE SEQUENTIAL EXTRACTION  
RESULTS – BK2**





#### Notes

Bar with white fill and colored outline indicates a non-detect result with the value reported as the method detection limit (MDL) in mg/kg.

bgs – below ground surface

ft – feet

- Water Soluble
- Adsorbed
- Carbonate Bound
- Oxide Bound
- Organic/Sulfide Bound

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SUPPLEMENTAL BACKGROUND SOIL AND GROUNDWATER  
INVESTIGATION REPORT

## SOLUBLE FRACTION PERCENT PLOTS – BK2

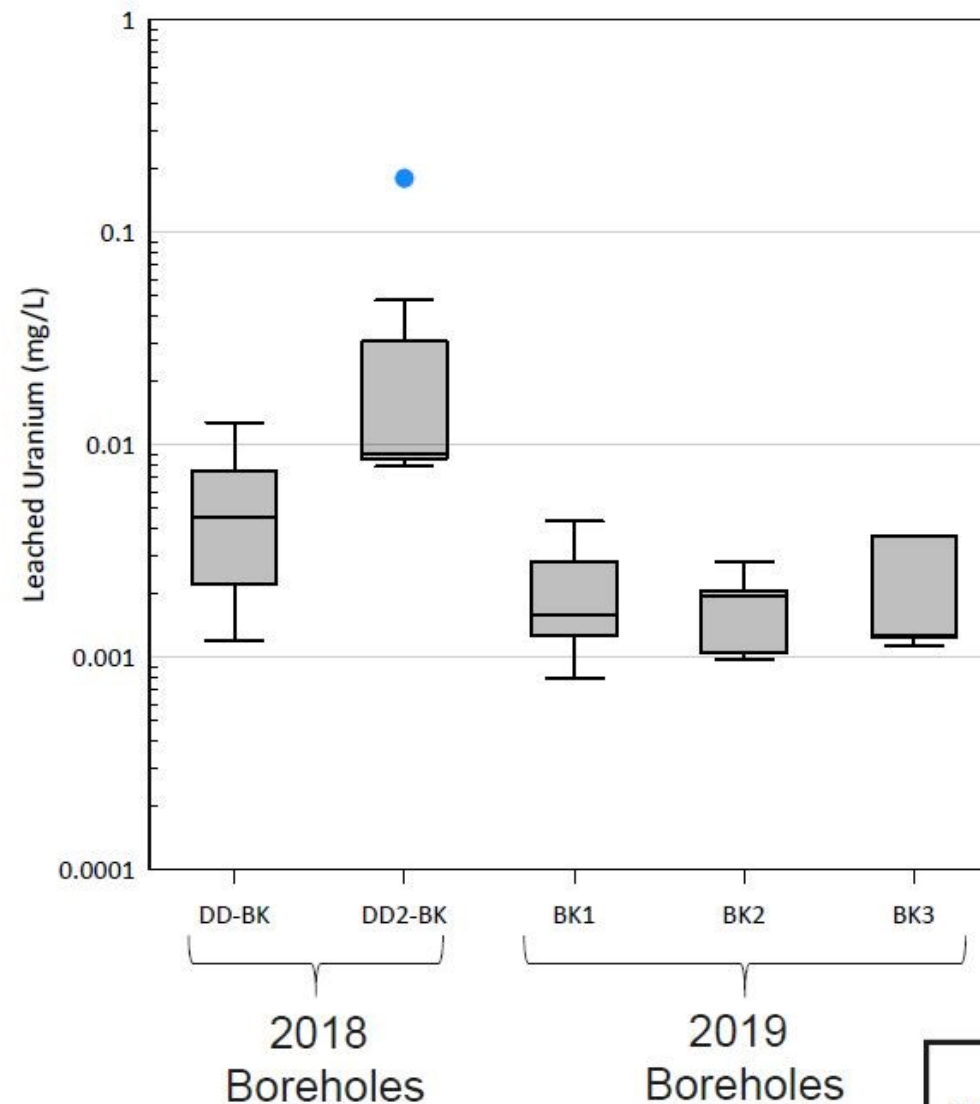


#### Notes

All diagrams are at the same horizontal scale  
 Ca – calcium  
 CO<sub>3</sub> – carbonate  
 HCO<sub>3</sub> – bicarbonate  
 K – potassium  
 meq/l – milliequivalent per liter  
 Mg – magnesium  
 Na – sodium  
 SO<sub>4</sub> – sulfate

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 INVESTIGATION REPORT

#### STIFF DIAGRAMS ACROSS THE CHANNEL



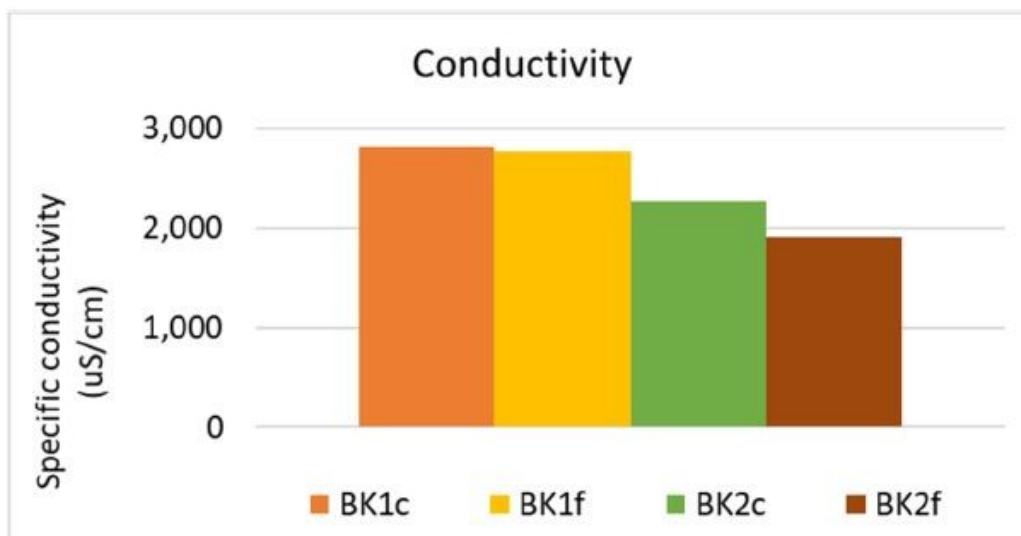
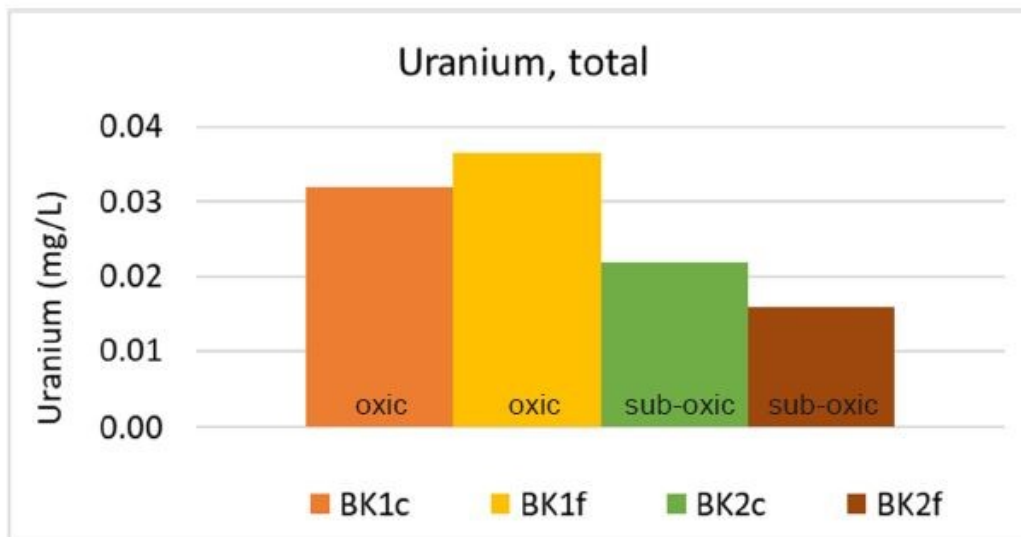
#### Notes

Sediment from 2018 boreholes was extracted with 0.0144 M sodium bicarbonate and 0.0028 M sodium carbonate (Kohler, et al. 2004; 18 hour extraction); sediment from 2019 was extracted with DI water (1 hr.) and Kohler et al. 2004 extraction solution (1 hr.); i.e., SSE Steps 1 and 2 (data is summed).

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SUPPLEMENTAL BACKGROUND SOIL AND GROUNDWATER  
INVESTIGATION REPORT

#### EVALUATION OF URANIUM LEACHING FROM SEDIMENTS IN BICARBONATE/CARBONATE SOLUTIONS





#### Notes

mg/l – milligram per liter  
 mV – millivolt  
 Oxic – dissolved oxygen > 1 mg/l  
 sub-oxic – dissolved oxygen 1-0.1 mg/l  
 uS/cm – microSiemen per centimeter

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 SUPPLEMENTAL BACKGROUND SOIL AND GROUNDWATER  
 INVESTIGATION REPORT

### URANIUM AND CONDUCTIVITY IN BK WELLS



# SUMMARY OF HOMESTAKE/ARCADIS CONCLUSIONS

- COARSER GRAINED SEDIMENTS WITH HIGHER CONDUCTIVITY IN WEST
- MORE AGGRESSIVE OXIDATION IN WEST – FAVORABLE FOR URANIUM MOBILIZATION
- HIGHER CONCENTRATIONS OF URANIUM IN SEDIMENTS IN WEST (AT DD AND DD2)
- NATURAL URANIUM RICH SEDIMENTS ARE IN CONTACT WITH GROUND WATER HIGHER IN TDS, ALKALINITY, CALCIUM

# SUMMARY OF HOMESTAKE/ARCADIS CONCLUSIONS

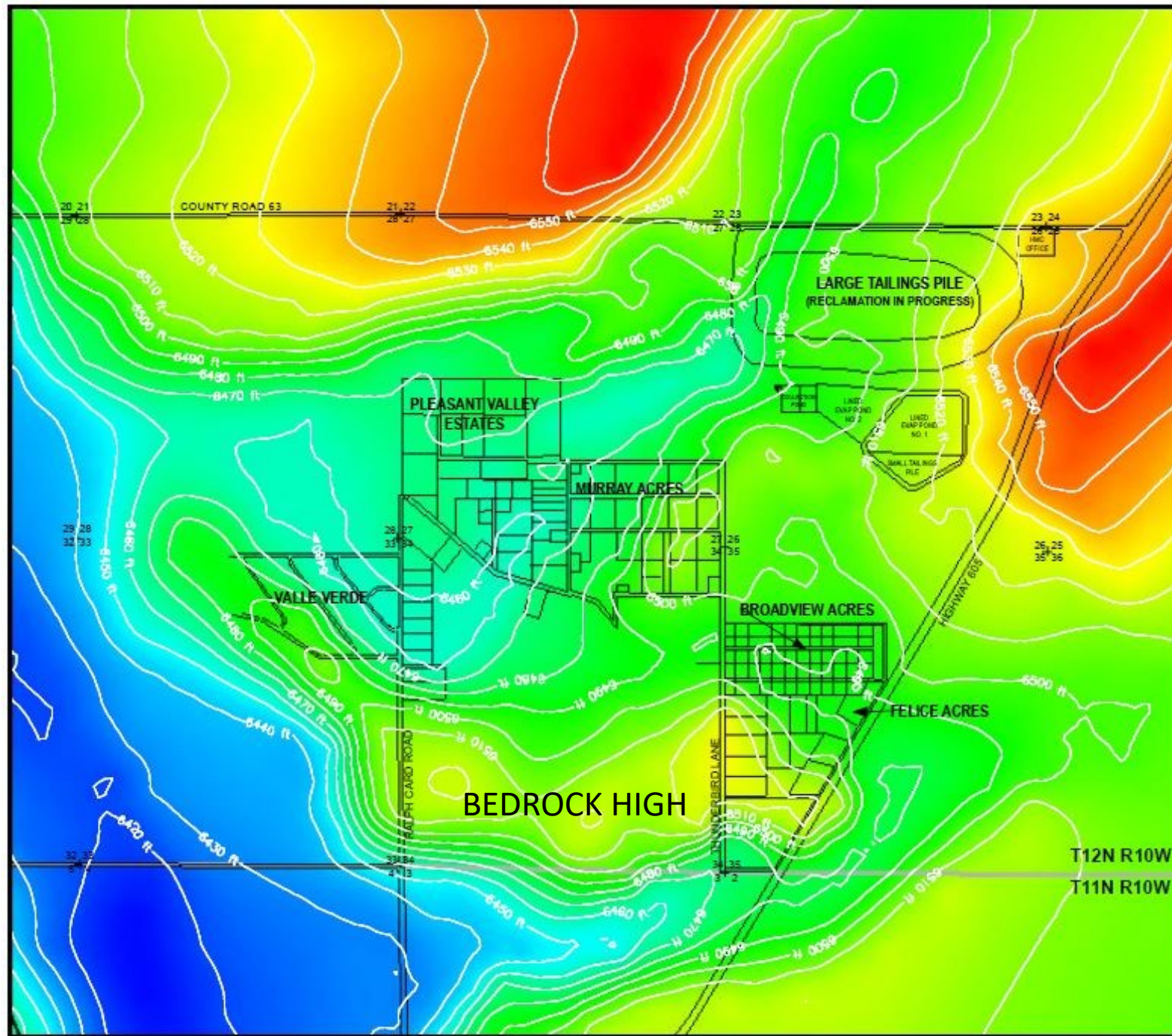
- VARIABILITY AND HETEROGENEITY OF ALLUVIAL SYSTEM IS CAPTURED BY UPGRADIENT WELL NETWORK
- REPRESENTS RANGE OF NATURAL URANIUM CONCENTRATION VARIATIONS PRIOR TO MOVING ON SITE
- NUMERICAL APPROACH TO DEVELOP SITE BACKGROUND STANDARDS IS APPROPRIATE

# GROUND WATER FLOW PATHS



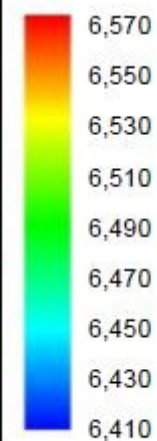


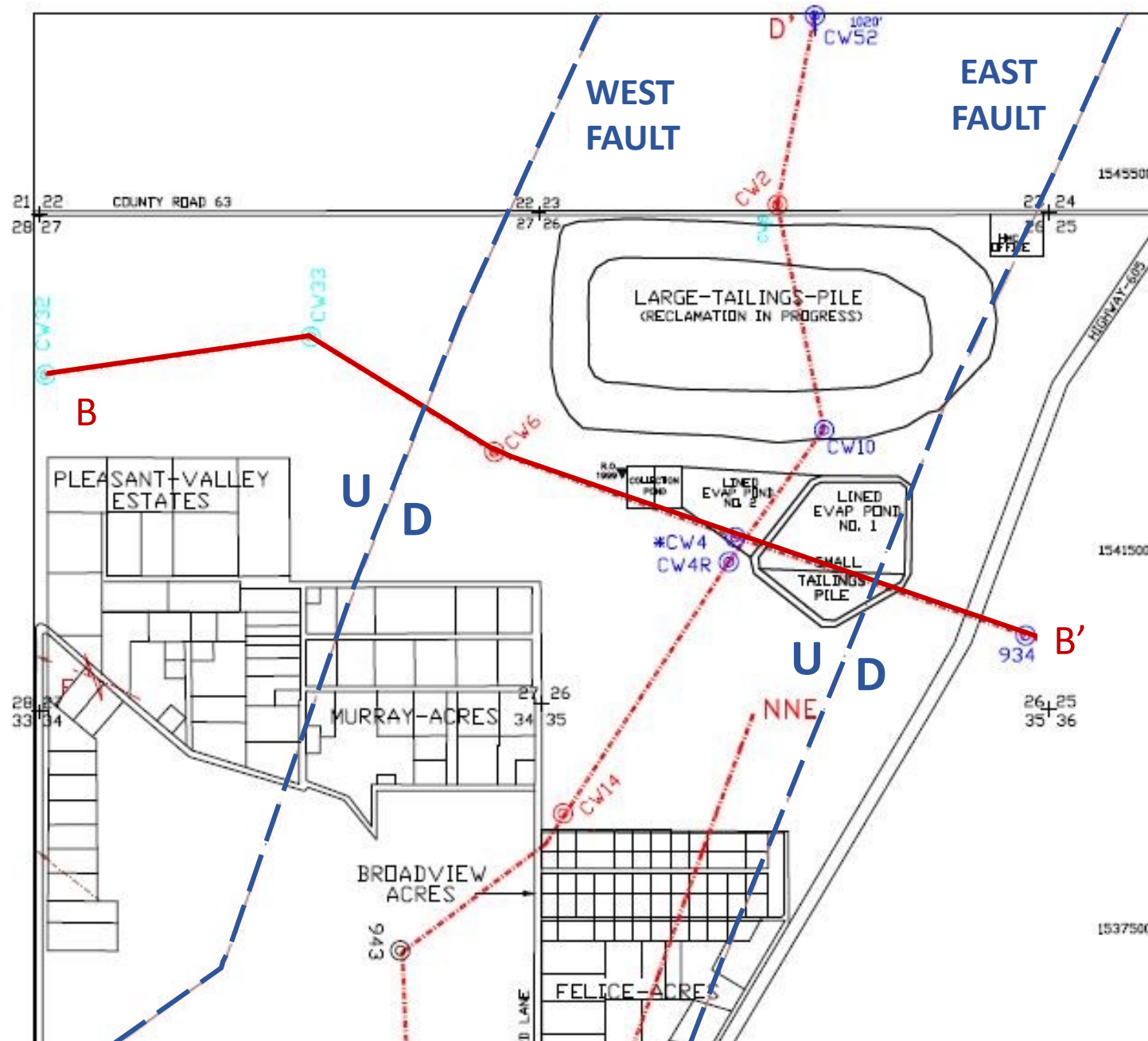
# BASE OF ALLUVIUM STRUCTURE MAP



## LEGENDS:

Base of  
Alluvium  
Elevation  
(FT-AMSL)

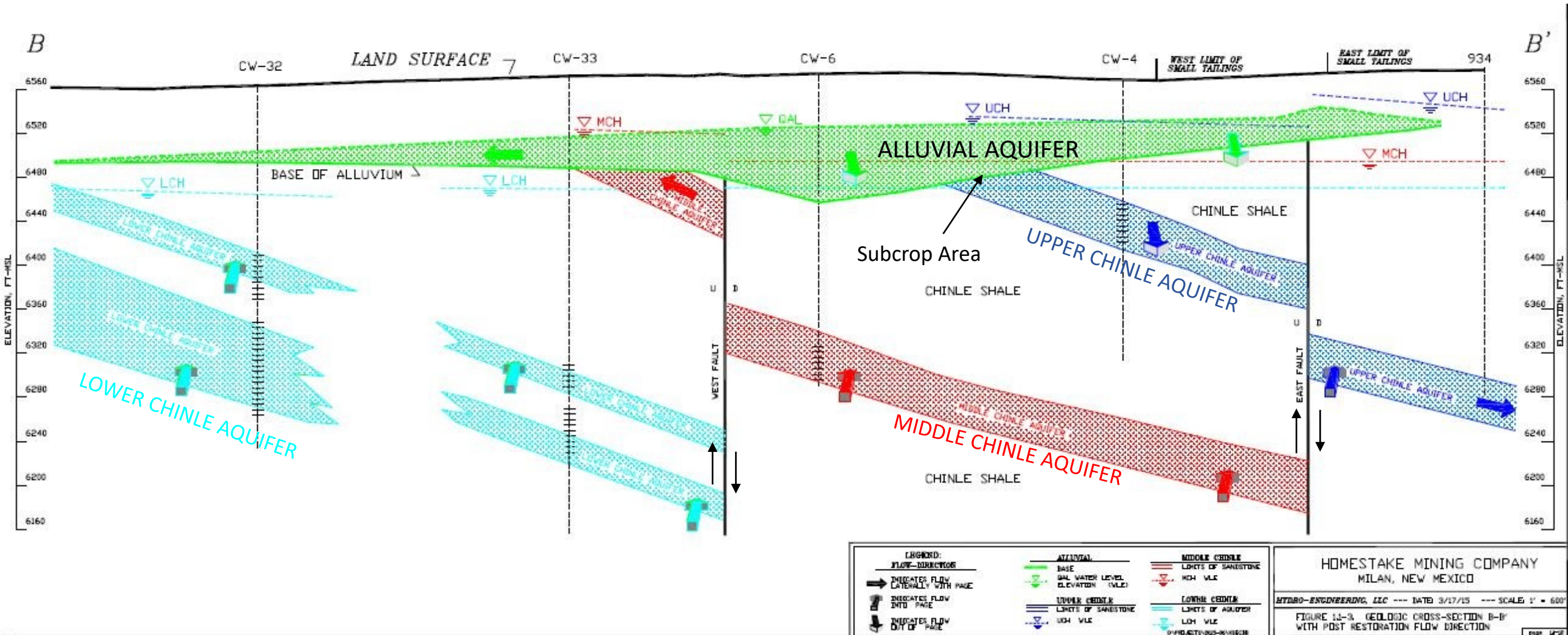




# HOMESTAKE HYDROGEOLOGIC CROSS SECTIONS

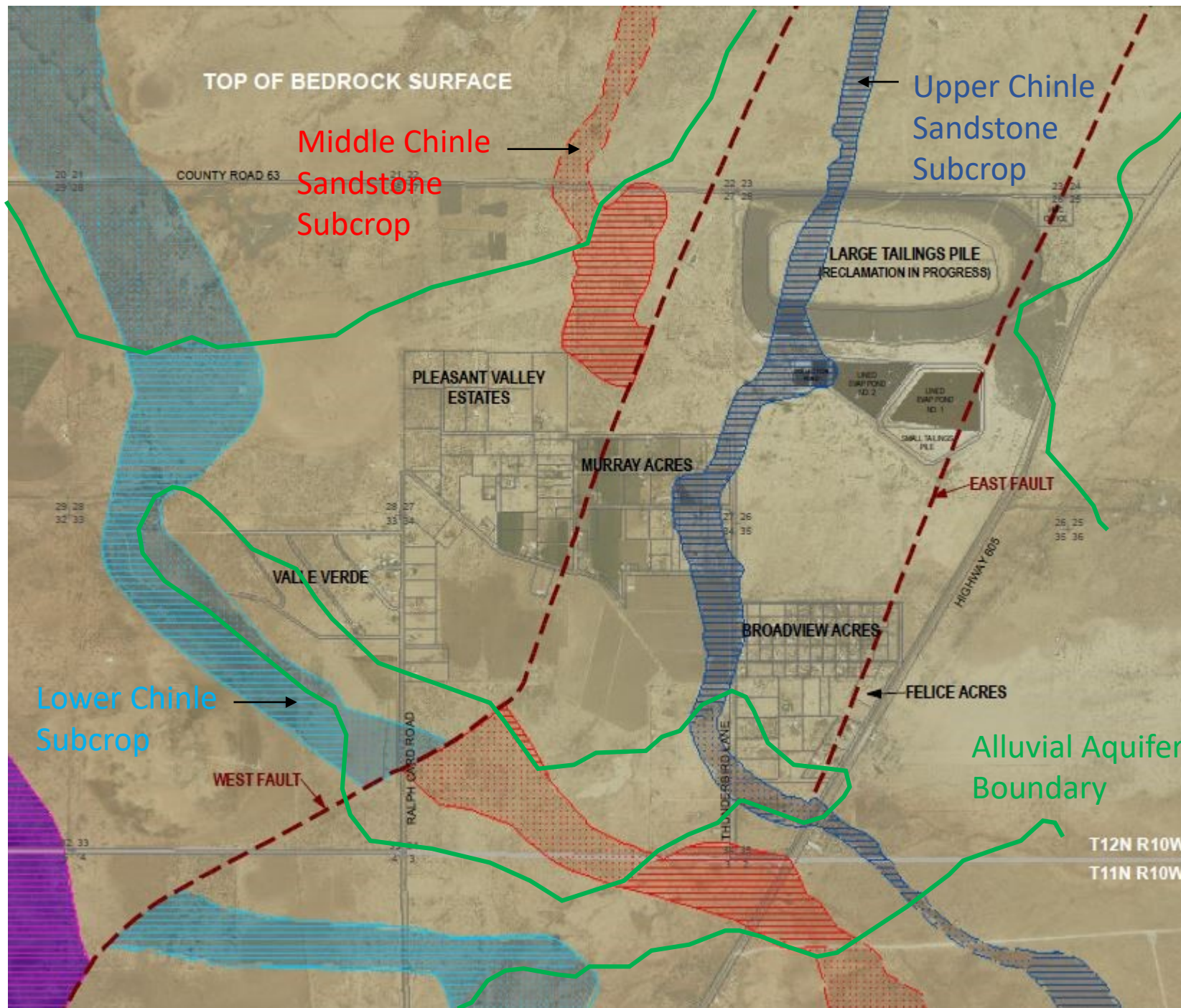


# HYDROGEOLOGIC CROSS SECTION B-B'

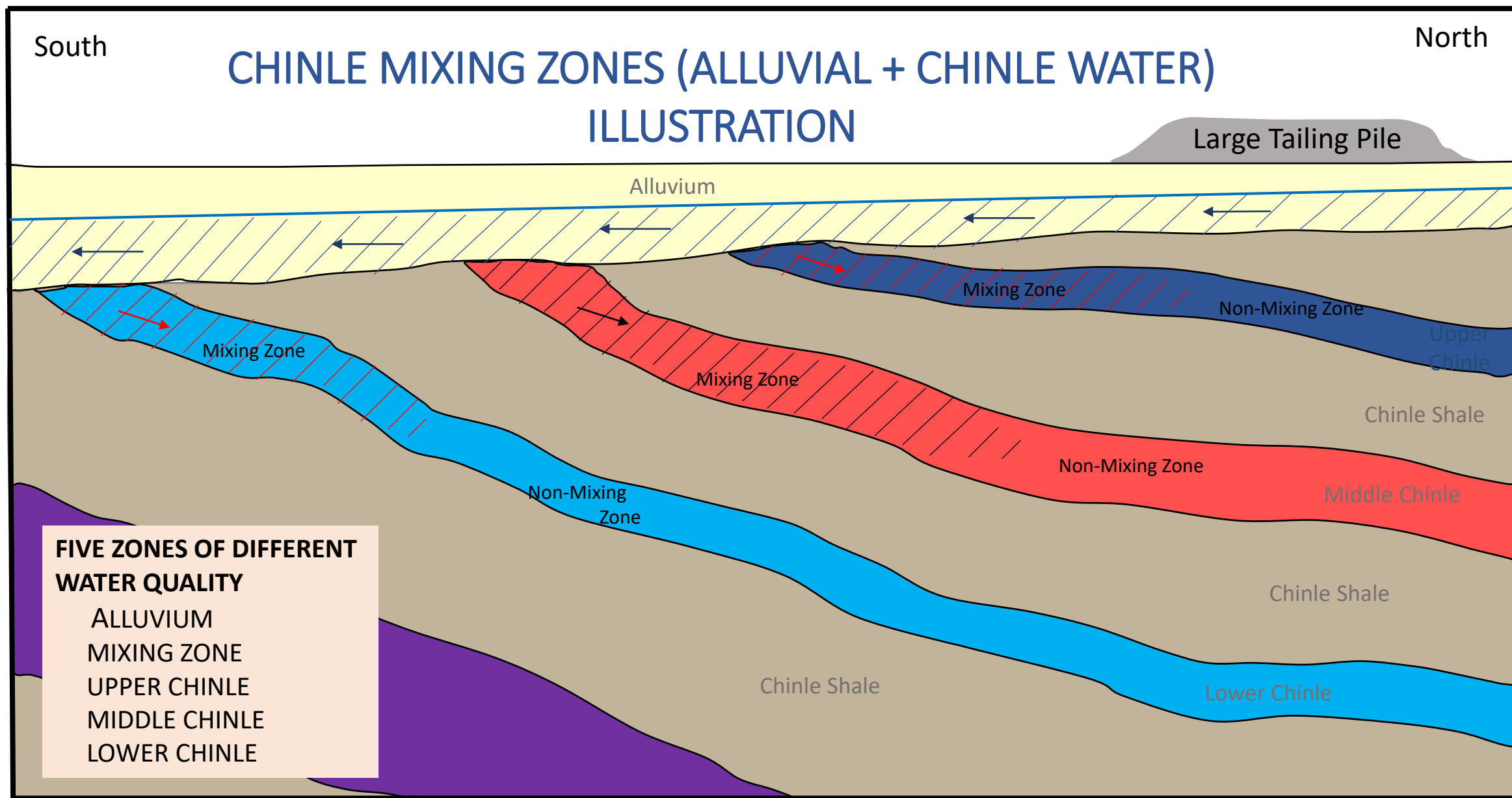


From 2017 Homestake Annual Report



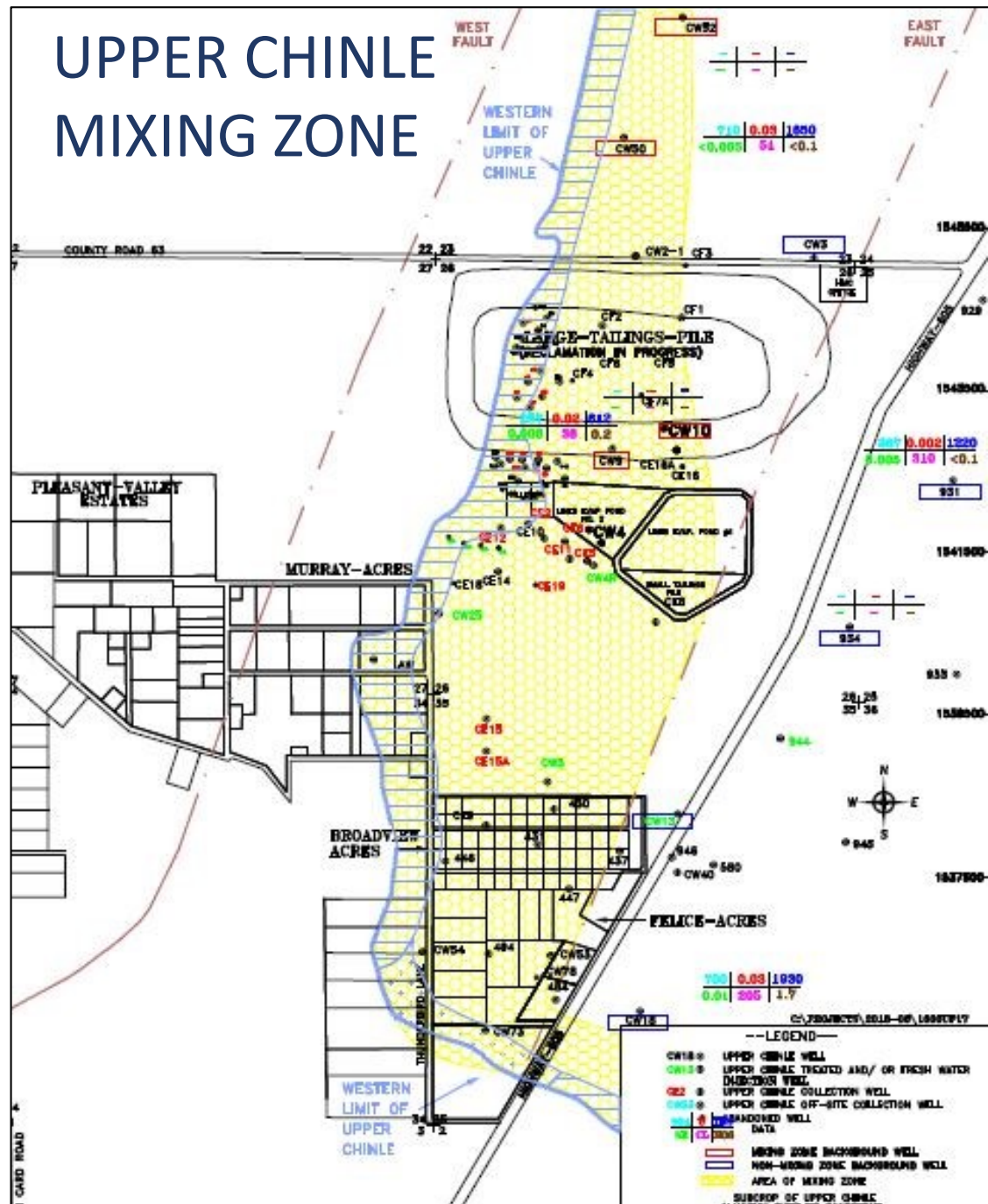


# TOP OF BEDROCK SURFACE MAP

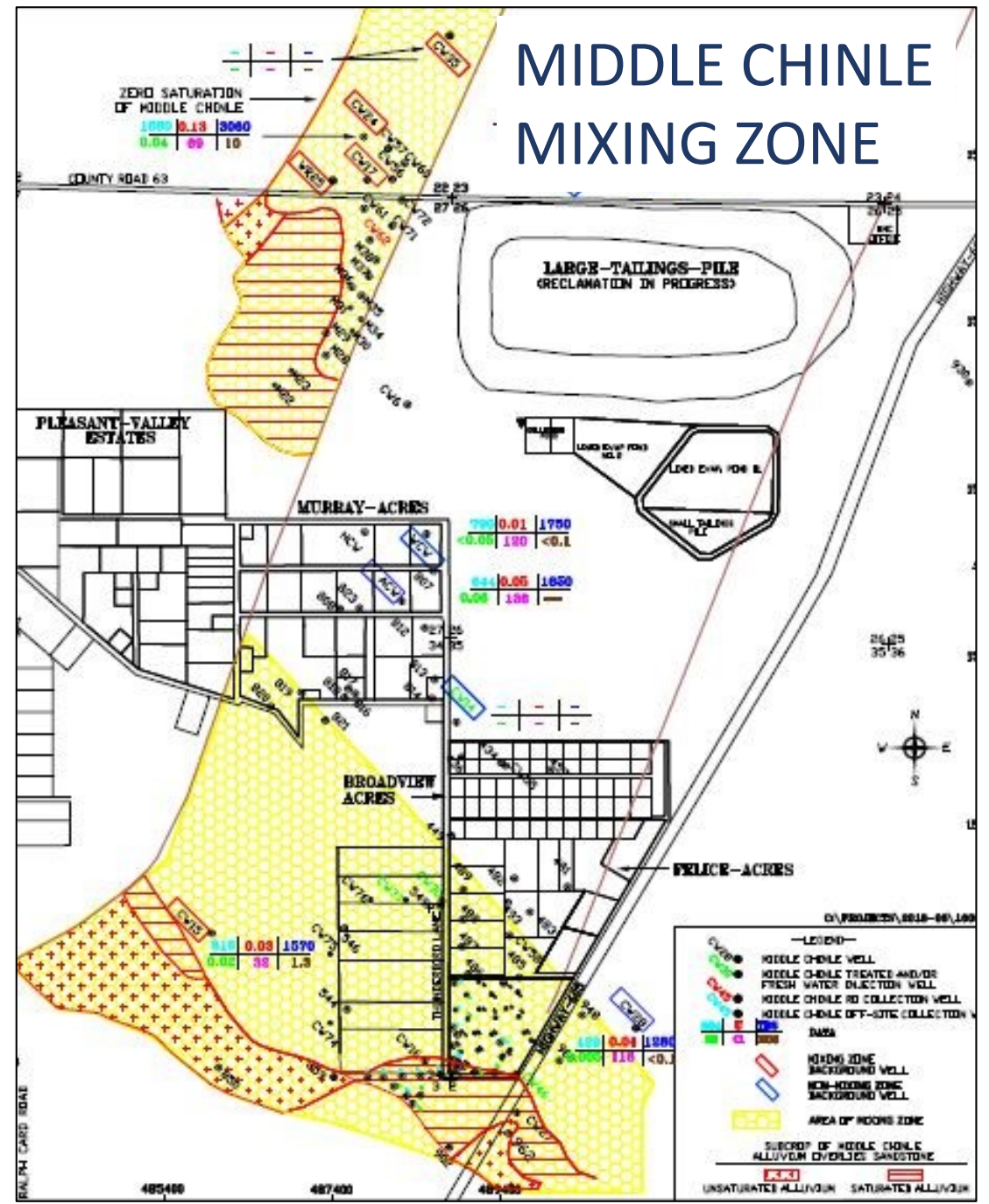




# UPPER CHINLE MIXING ZONE



# MIDDLE CHINLE MIXING ZONE



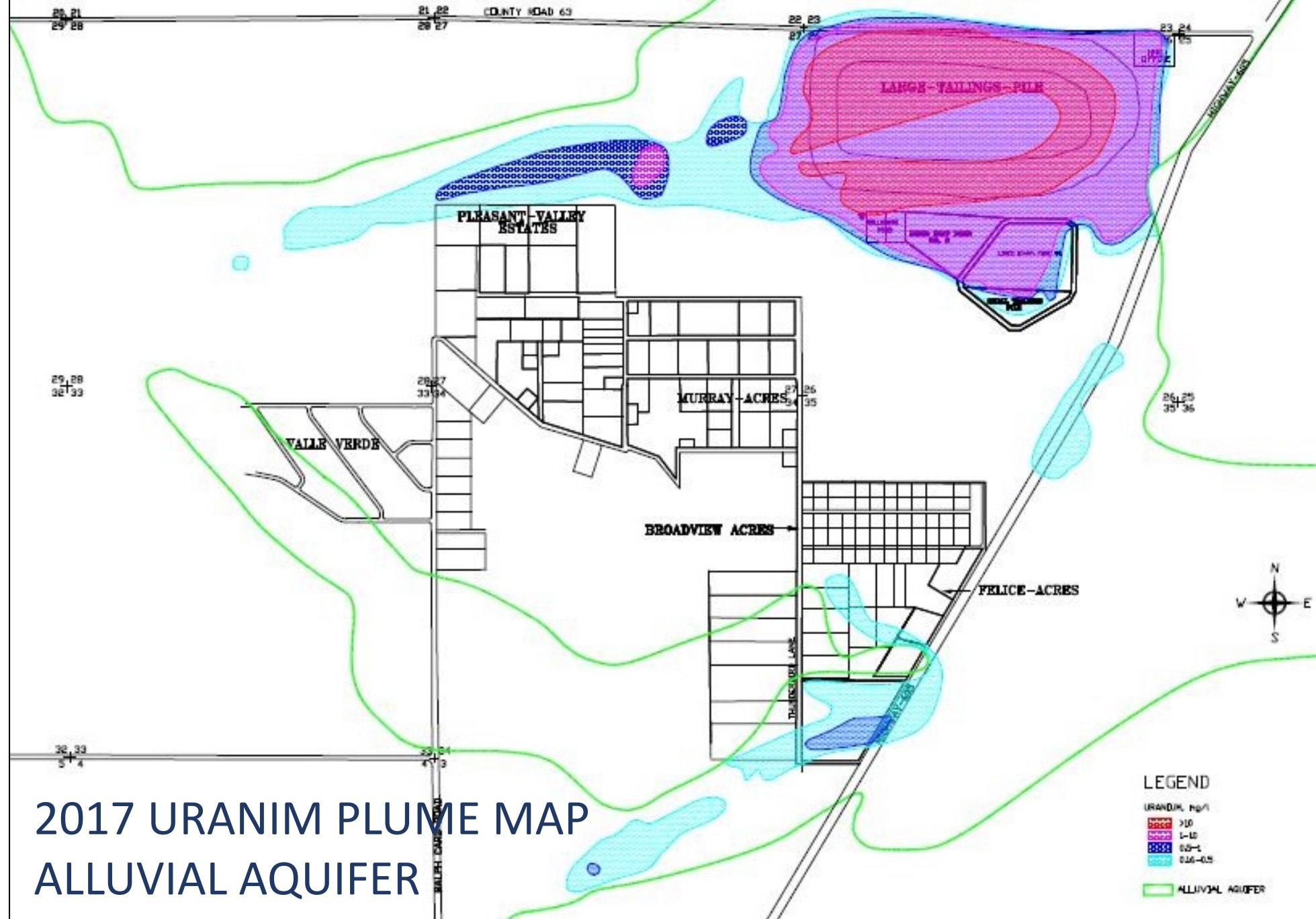


# BACKGROUND LEVELS ESTABLISHED IN 2004

## Selected as Cleanup Levels

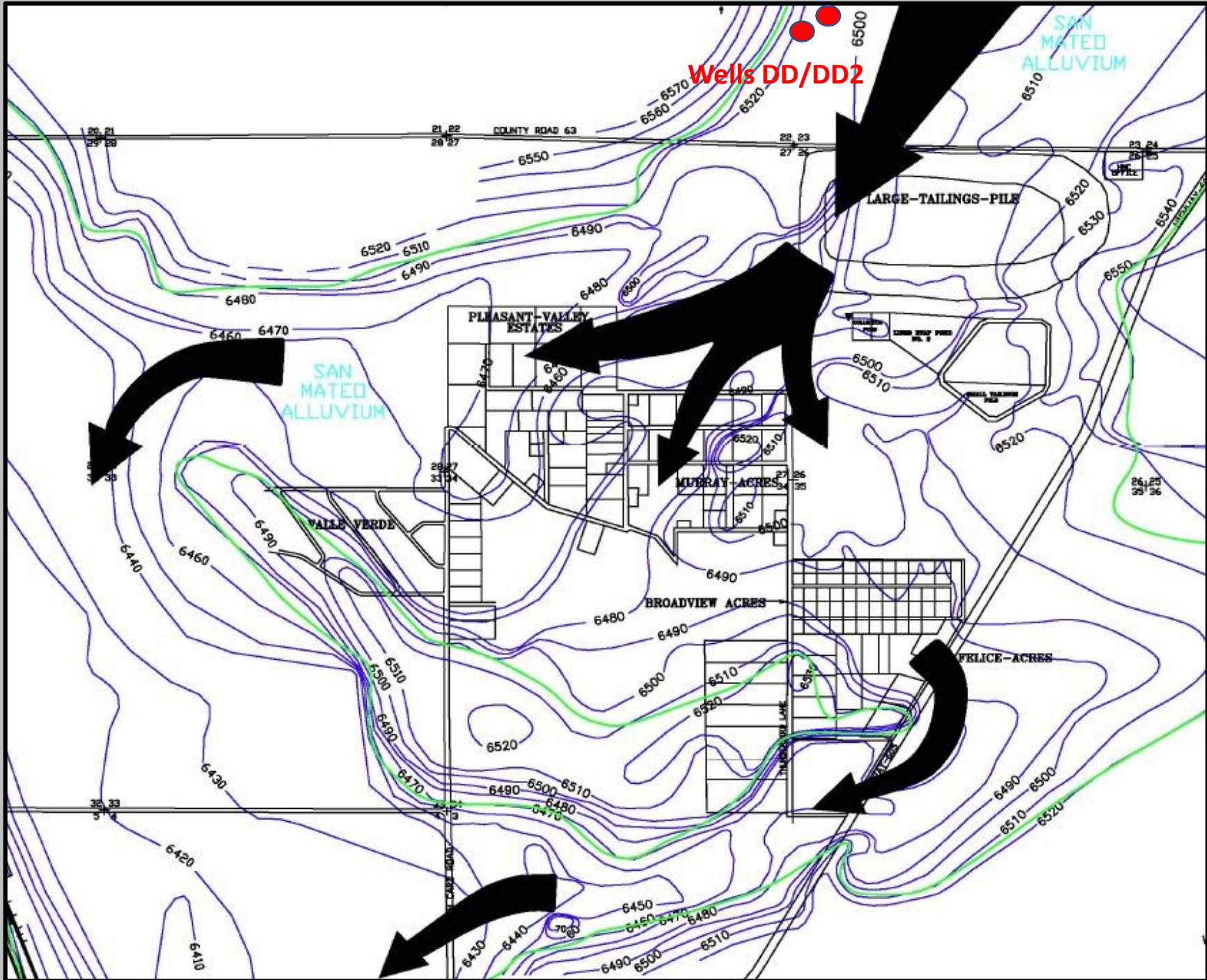
Constituent	Federal MCL	Alluvium	Chinle Mixing Zone	Upper Chinle Non-mixing Zone	Middle Chinle Non-Mixing Zone	Lower Chinle Non-mixing Zone
Uranium (µg/L)	30	160	180	90	70	30
Selenium (µg/L)	50	320	140	60	70	320

Approved by NRC and State  
Agreed with by EPA



From 2017 Homestake Annual Report





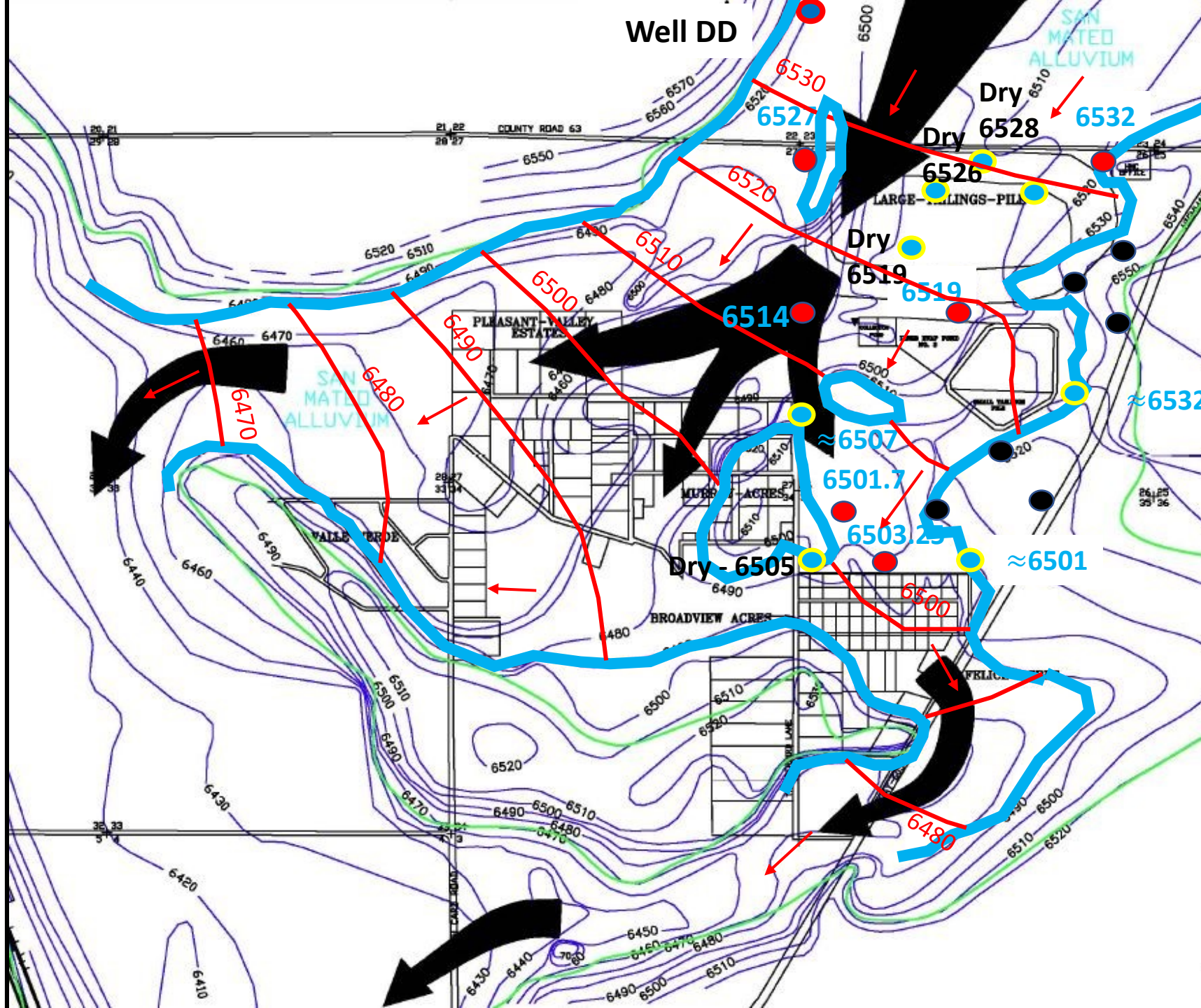
POST RECLAMATION  
ESTIMATED BASE FLOW  
ALLUVIAL AQUIFER

Base of Alluvium  
Structure Contour Map

Ground Water  
Flow Path Proposed  
By HMC

From HMC  
Background Report



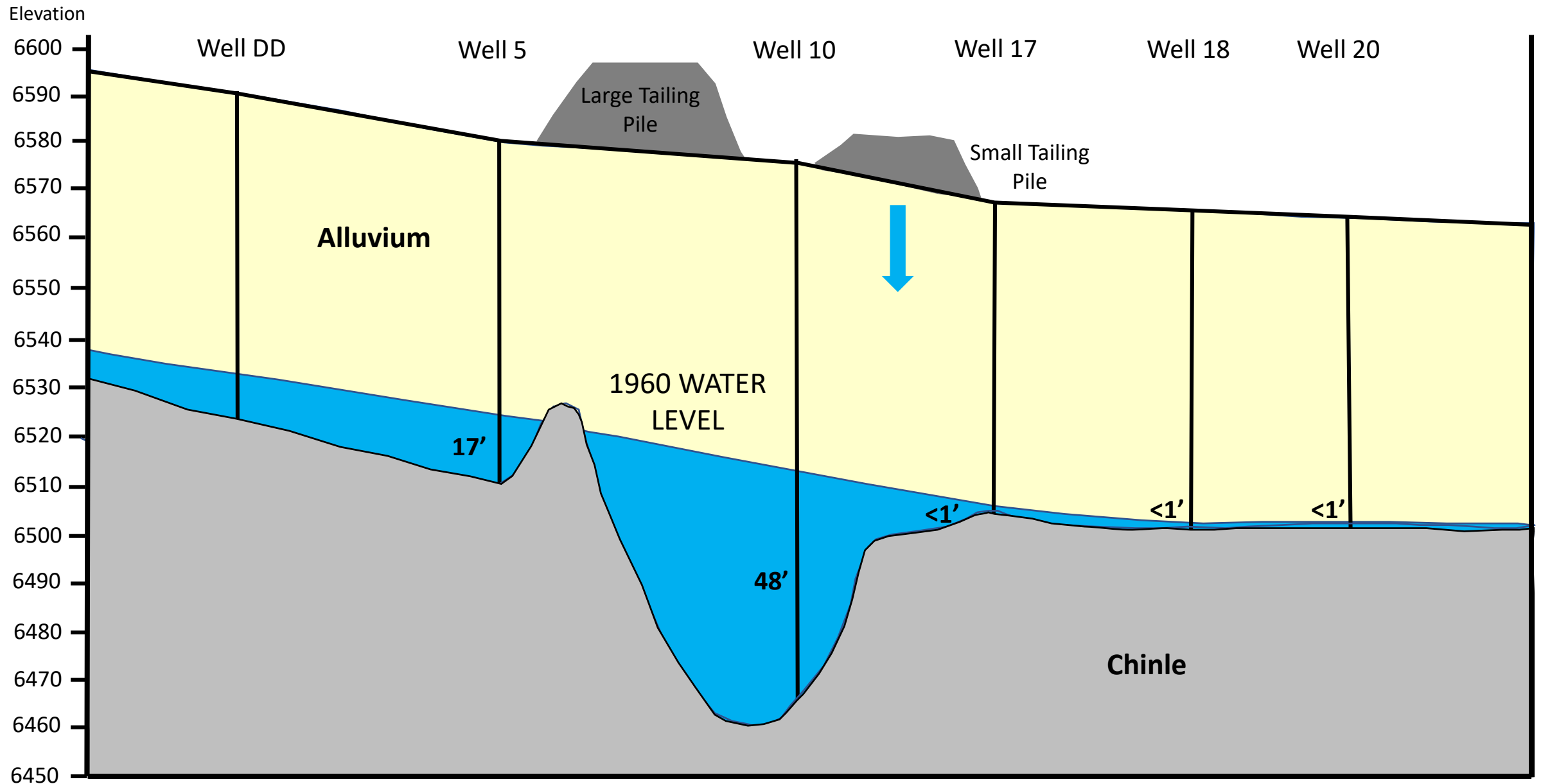




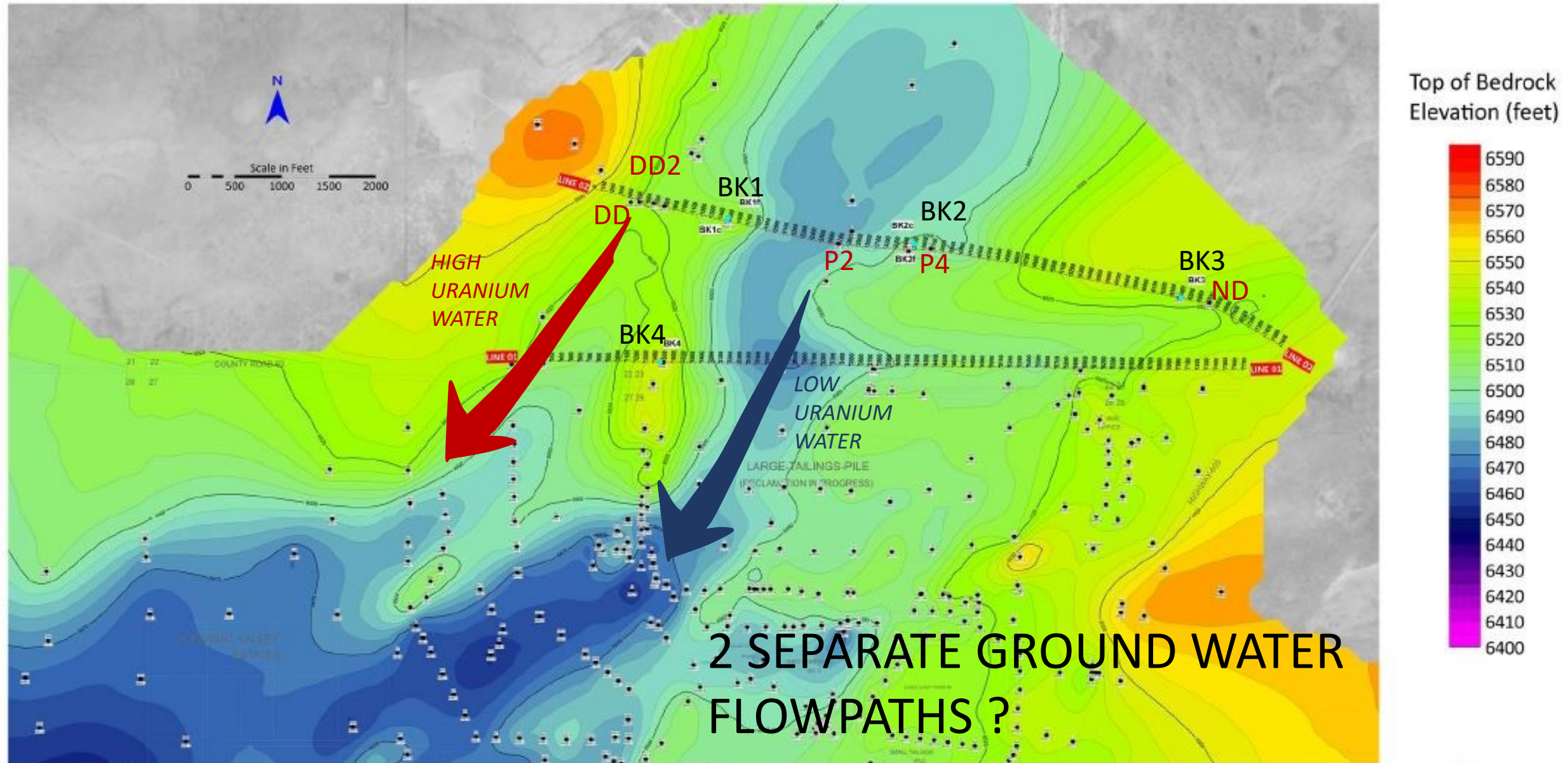


**C**

# HYDROGEOLOGIC CROSS SECTION C-C'

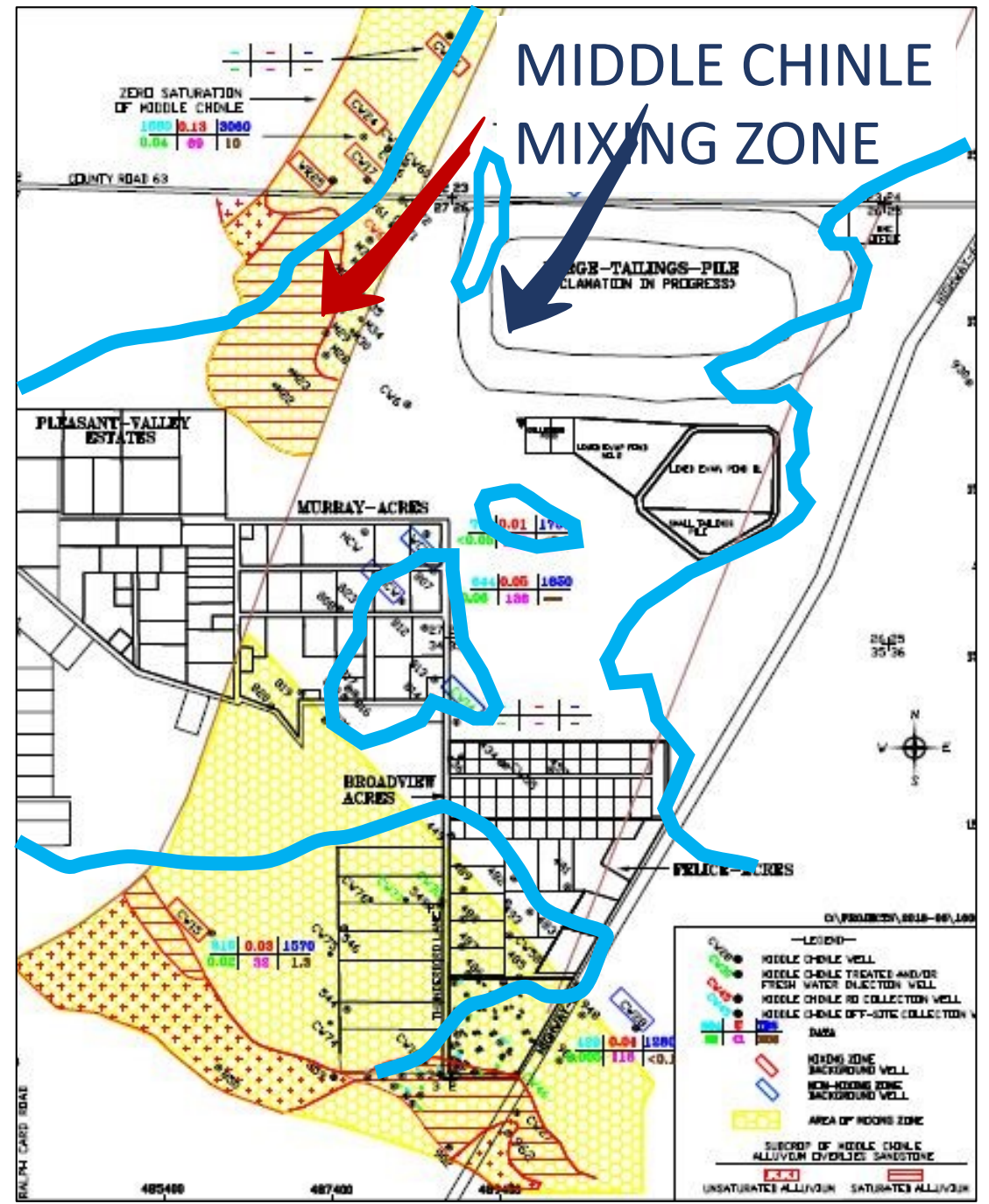
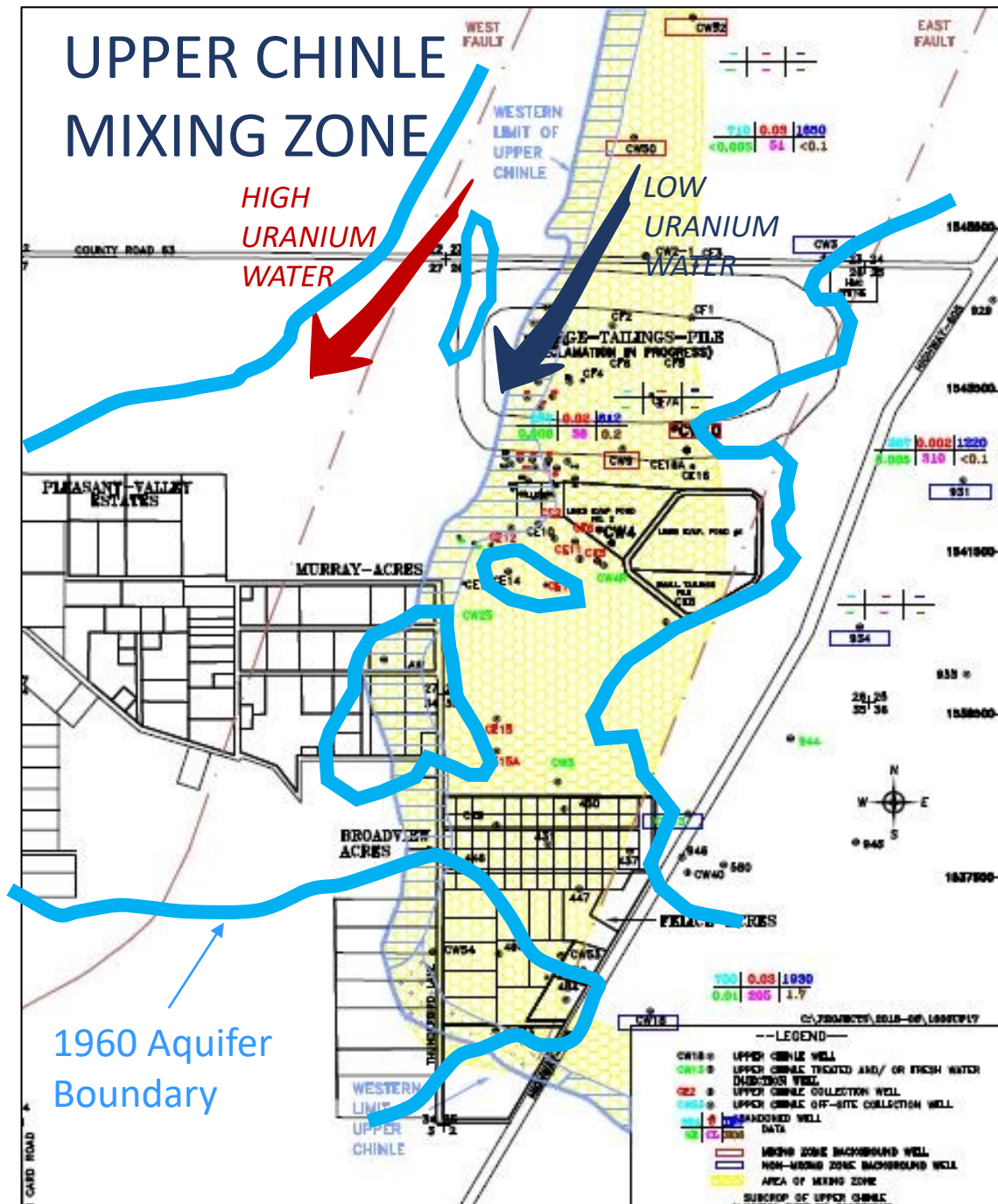
**C'**

# Top of bedrock elevation map



2 SEPARATE GROUND WATER FLOWPATHS ?







# SITE CHARACTERISTICS ASSOCIATED WITH FLOW PATHS UNDER CONSIDERATION BY EPA AND NMED IN ASSESSING BACKGROUND

- DOES HIGH URANIUM ALLUVIAL GROUND WATER RECHARGE ALL CHINLE AQUIFERS IN EACH FAULT BLOCK?
- ARE CURRENT BACKGROUND GROUND WATER CLEANUP STANDARDS APPROPRIATE FOR ALL AQUIFERS?

# NEXT STEPS

- MEET WITH HOMESTAKE – SEPTEMBER 17, 2019
- BRIEF UPPER LEVEL EPA/NM MANAGEMENT AND MAKE RECOMMENDATIONS ON BACKGROUND – OCTOBER 2019
- MEET WITH NRC TO DISCUSS BACKGROUND – OCTOBER/NOVEMBER 2019
- NOTIFY HOMESTAKE AND ALL OTHER STAKEHOLDERS OF DECISION